MITRAL VALVULOTOMY



Frontispiece A markedly distorted and calcified valve

Case No 61 (T D., N Y Hospital History No 651865) a 45 year old man was accepted for mitral valvulotomy because of severe exertional dyspnea and fatigue He was thought to have mitral stenosis, as the pre dominant lesion but with considerable aortic insufficiency At operation the surgeon found a marked degree of mitral insufficiency Only slight relief of the mitral stenosis was achieved but at the cost of increasing the insufficiency of the valve The patient was not improved clinically afterward. Congestive failure increased, signs of tricuspid insufficiency appeared The patient died two years and eight months after operation

The photograph of the mitral valve demonstrates the marked degree of distortion and calcification as an example of that found in many of these valves Both the valve ring and the valve leaflets were calcified and there was extensive erosion of the endocardium over the masses of calcium. At autopsy the valve orifice measured 3.5 by 0.5 cm. No distinct marks of the mitral valvulotomy which had been performed 2⅔ years earlier were found. All chambers of the heart were dilated. There was a fresh pulmonary embolus in the lower lobe of the left lung

The clinical course and other pertinent autopsy findings are found in Table 28

mitral valvulotomy

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PREFACE

When we had brought together and evaluated what we had accomplished by doing the operation of mitral valvulotomy in our first 100 patients with mitral stenosis we had already proceeded far into operating on another 200 patients We went through a gradual reorientation about the patients we would accept for operation and the extent of the preoperative work up which was optimal for carrying out satisfactory operation We then came to accept patients who were further advanced in their disease and were more seriously ill In many patients we found that neither angiocardiograms nor cardiac catheterization was needed in the evaluation On the other hand we found postoperatively that many patients especially women might have exacerbation of biliary tract symptoms due to cholecystitis and gallstones This led us to have gallbladder visualizations in all patients before operation If evidence of disease was revealed and there were symptoms we weighed the risk of doing the mitral valvulotomy first and the occurrence of an acute gallbladder attack in the postoperative or convalescent period against the risk of attacking first the gallbladder in a patient with mitral heart disease of the proportions which we thought required mitral valvulotomy and leaving the gallbladder operation until two to three months after operation

When we had come to many such changes in points of view after the earlier cases we were already far advanced as we have said in operating on the second and third 100 patients At this time we decided to delay publication of our evaluations until we could analyze the results in the second and third one hundred patients and compare them with the results in the first 100 patients It was in this stage of our analyses that Mr Charles C Thomas Publisher offered to publish our data in a monograph which after some consideration we accepted

The evaluation of results in terms of improvement is difficult in

CONTENTS

MITRAL VALVULOTOMY

PART ONE

MITRAL VALVULOTOMY IN THE FIRST ONE HUNDRED PATIENTS IN THE YEARS 1951, 1952, 1953

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Section I

SELECTION AND MANAGEMENT OF PATIENTS

INTRODUCTION

In 1925, Sir Henry Souttar demonstrated the surgical approach to the mitral valve through the left auricular appendage in a young woman of 25 years of age with mitral stenosis. This seems to have attracted little attention. Various approaches were attempted by Cutler, Beck and Levine, and Smithy as well as others without much success. Bailey and his associates in 1946 were the first to employ Souttar's approach on a group of seriously ill patients accomplishing commissurotomy followed by considerable relief from the symptoms of mitral stenosis. Concomitantly Harken and his co-workers treated patients by a similar approach and at the same time did careful and detailed studies both before and after operation. During the past decade the surgical treatment of mitral stenosis has been embarked upon by a large number of groups of physicians from hospitals widely distributed over the world. It is now established as a satisfactory surgical therapy that may be accomplished with an anticipated morbidity and mortality comparable to that associated with surgical procedures of comparable magnitude. The objectives to provide relief of symptoms, overcome disability and prolong life with minimal risk and disturbance to the patient are being more frequently attained as experience increases.

The surgical treatment of mitral stenosis is a many-faceted problem. The evaluation and selection of patients for operation, the preoperative preparation, the operation, and the postoperative care and management require the skill and judgment of a number of physicians with special backgrounds. A realization of the importance of cooperative effort before embarking upon this work

led to the formation of an interdepartmental cardiovascular con ference group consisting of members from the departments of Medicine Surgery Pediatrics Obstetrics Anesthesia Radiology and the Cardio-Pulmonary laboratory Careful records have been kept of all patients These now provide data which enable us to review our experience

It is our purpose to present the information that has seemed most important to us in the selection and management of the first 100 patients operated upon for mitral stenosis in the Depart ment of Surgery of The New York Hospital-Cornell Medical Center The maximum benefit with the minimal risk in any type of surgical therapy is dependent upon meticulous attention to detail while adhering to a comprehensive plan of approach Therefore this report includes information that varies from the specific and concrete to the general and seemingly unrelated

SELECTION OF CASES FOR MITRAL VALVULOTOMY

The selection of cases for mitral valvulotomy can at times be a simple problem and at other times it is difficult to arrive at a decision

One of us Dr Harold J Stewart has seen together with the Assistant Residents and Fellows in Medicine (Cardiology) the patients on whom mitral valvulotomy has been performed by Dr Glenn s surgical group at The New York Hospital On the basis of *clinical evaluation* we try first to arrive at the suitability of patients for the procedure and then if special observations are indicated such as cardiac catheterization studies to see how these contribute to or modify our clinical impressions For ex ample catheterization was carried out in 92 of the first 100 patients as a part of the study but we have found that we can proceed without these data in most patients

Finally prior to operation many patients (especially if there are any complicating factors) are discussed at our interdepartmen tal cardiovascular conference to make final decision about opera tion and to discuss individual problems in each case with a view to anticipating any difficulties that might arise and how they can be met At this conference are members of the Department of

The degree of mitral insufficiency as estimated by the regurgitant stream through the mitral orifice at operation has not always, however, agreed with either the estimate made clinically from the murmur and left ventricular enlargement, etc, or with the estimate made from the catheterization curves Mitral insufficiency still gives us most difficulty in this regard

From this group of patients who exhibit predominant mitral stenosis, we have accepted for operation

a Those with auricular fibrillation, as well as those with normal sinus rhythm

b Patients whose hearts were large, as demonstrated by x-ray, fluoroscopy, electrocardiogram and physical examination, provided enlargement did not point to predominant mitral insufficiency or to predominant aortic lesions

c Patients with moderate grades of aortic lesions, namely, insufficiency with or without slight stenosis if the predominant lesion was mitral stenosis An early diastolic murmur alone without peripheral signs of aortic insufficiency does not appear to contraindicate operation An early diastolic murmur in the second left interspace may be confused with the Graham-Steele murmur of pulmonary insufficiency associated with mitral stenosis In this group we avoided operation on the mitral valve in patients with definite evidence of aortic stenosis

d Patients with histories of hemoptysis indicating an increase in pulmonary artery pressure which might be reduced by enlarging the mitral orifice

e Patients with histories of pulmonary edema, pulmonary infarctions and arterial emboli

f Patients with chronic congestive heart failure who were not responsive to medical therapy

g Those patients without evidence of *organic* tricuspid disease, patients with functional tricuspid insufficiency, however, have not been ruled out on the basis of this lesion alone In a patient who had both mitral stenosis and tricuspid stenosis, mitral valvulotomy was done first, followed later by tricuspid valvulotomy

h Patients with no evidence of activity of rheumatic infection Patients with chronic rheumatic heart disease, with chronic heart

failure especially those with auricular fibrillation may run a slight fever In certain of these it may be difficult to rule out activity of rheumatic infection The elevation of the sedimentation rate of the antistreptolysin titer and the presence of increased amounts of C-reactive protein form the basis for decisions *

1 Patients without evidence of subacute bacterial endocarditis In the first 100 patients who came to operation there were none who had recovered from subacute bacterial endocarditis The scarring and deformity of the valve with recovery from this in fection presents a special problem in attempting to enlarge the mitral orifice

3 Patients with recent histories of pulmonary infarction in whom the operation has been delayed for some weeks until we felt that convalescence therefrom was complete Anticoagulant therapy on these patients has been discontinued before operation

Age was not a determining factor in the patients we have selected provided they were suitable for operation on other grounds

The opinion of the anesthetist as to whether the patient could tolerate anesthesia has been an important factor in our decision

Whether the patient developed râles in the lungs with exercise during catheterization was helpful in estimating the functional capacity and in being forewarned about hazards during operation in those patients in whom these data were available

Patients have been accorded the usual medical therapy until considered to be in the best possible condition for operation At times many weeks may be required to achieve this goal Most patients have required digitalis before operation — patients with normal rhythm as well as those with auricular fibrillation We have not used anticoagulants as an *adjunct* to operation as we did not wish to cloud the effects of valvulotomy

The teamwork of the group which has been associated in taking care of these patients has been one of the main factors contributing to the proper selection of patients the successful per

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* We wish to thank Sidney Rothbard M.D for making these observations and aiding in decisions about such patients.

formance of this operation in very sick patients with a narrow margin of reserve, and their optimal postoperative care However, the chief responsibility for selection of patients for operation rests upon the internist

CONTRAINDICATIONS TO OPERATION

Contraindications included (1) coexistent aortic valvular disease, if this was considered the predominant lesion, (2) a large amount of mitral insufficiency, in so far as this could be determined preoperatively, (3) active rheumatic fever, (4) history of subacute bacterial endocarditis within the preceding four to six months, (5) active infections of any etiology

PREPARATION FOR OPERATION, ANESTHESIA, AND OPERATION

Preparation Maintenance digitalis was continued in those patients (74 in all) who were already digitalized An additional eight patients underwent initial digitalization in the hospital preoperatively All patients were placed on a 1 0 to 3 0 gm salt diet, and weighed frequently, usually daily Those who had edema were treated with mercurial diuretics until dry weight was obtained In a few instances an intensive diuretic program of mercurials and ammonium chloride failed to render the patient edema-free, these patients were operated on when maximal diuresis had been achieved Operation was not carried out until patients were in the best functional state it was possible to attain Many weeks may be required in this preparation Patients who were presented to us for consideration in whom it was thought that low grade rheumatic activity might be present were kept under observation until they were considered inactive The curve of the C-reactive protein titrations were helpful in this connection

The night before operation, patients were typed and cross-matched (with 2000 to 2500 cc of blood being placed on call) and were started on procaine penicillin 400,000 units and either streptomycin or dihydrostreptomycin 0 5 gm twice daily intramuscularly

Anesthesia. As is so often the case in surgery, much of the risk of an operative procedure lies in the anesthesia In this group

of patients a very low cardiac reserve in a malfunctioning heart is a common finding as is a poorly functioning pulmonary system as the result of pulmonary hypertension and sclerosis A thorough understanding of these physiological changes on the part of the anesthetist is essential and expert administration of the anesthetic agent to maintain a high oxygen concentration in the blood is of the greatest importance Our patients have had the benefit of meticulous induction and maintenance of a light anesthesia by our chief of anesthesiology Joseph F Artusio Jr M D and his associates At present the analgesic stage of anesthesia is now used throughout the operation for the patient during mitral valvulotomy Operations performed directly upon the heart in the extremely poor risk patient make a light level of anesthesia mandatory It has been found that patients maintained in analgesia have withstood trauma acute blood loss and the operative position much better than those patients maintained in deeper levels of anesthesia

The analgesic stage is not fraught with the dangers of heightened reflex irritability rather it has been repeatedly demonstrated that this degree of anesthesia is salutary to the circulation

The analgesic stage is accomplished by the use of ether and oxygen Verbal contact is established and maintained with the patient during the entire operation The electroencephalogram is used to provide an objective criterion for the depth of anesthesia The electrocardiograph is also used as a continuous monitoring instrument to demonstrate continuous minute to minute changes in cardiac rate and rhythm Thus one is able to detect minor changes in the electrical activity of the heart and brain and the status of the circulation in order to prevent serious mishaps

When preparing the patient for operation provision is made for rapid and adequate blood replacement by inserting an intravenous cannula in a vein in each leg Two liters of blood are kept at hand during the operation to be given rapidly under pressure should the washing out of intraauricular thrombi or inadvertent injury cause a loss of blood. Any blood loss is carefully estimated immediately by weighing all sponges and by measuring any blood removed by suction

Operation. After induction of anesthesia, with the patient in position, the left thorax is slightly elevated on a folded sheet placed under it from the shoulder to the level of the twelfth rib. The heart is approached through a left anterior, lateral incision. The fourth rib is resected sub-periosteally from its costo-sternal junction to the posterior axillary line and the pleura then incised to enter the left chest. The texture of the lung and its rate of collapse are noted, and the degree of heart enlargement, the thickness, nature and tenseness of the pericardium, the prominence of the pulmonary vessels and the presence or absence of palpable thrills are all recorded. If additional exposure is desired, the cartilagenous portion of the third rib is divided sub-periosteally near the costo-sternal junction. The pericardium is then incised two centimeters medially to the phrenic nerve from the superior portion of the pulmonary vessel to the mid-portion of the left ventricle and if additional exposure is needed, a T-extension made medially parallel to the auriculo-ventricular junction. As the anesthetist occludes the carotids by external pressure, the left auricular appendage is examined by the surgeon for evidence of thrombi. One per cent procaine is injected at the base of the auricular appendage where purse-string sutures of No. 3 braided silk are to be placed. With these in position the tip of the appendage is secured in a Statinsky type of clamp and the portion distal to the clamp is amputated. Fine silk sutures are then placed in the appendage wall to facilitate introduction of the right index finger into the auricle. The finger is introduced into the auricle while the more proximal purse-string sutures are held ready to be tightened as the clamp is removed.

With the finger inside the auricle the surgeon surveys the chamber as to size, thickness of the wall, presence or absence of thrombi. The current procedure in dealing with thrombi has been evolved as experience has accumulated. It is described in the section on arterial emboli in Part II (p. 113). The status of the mitral valve is then determined as to its degree of stenosis, its shape, amount of calcification and the extent, if any, of regurgitation. With a deliberate careful twisting motion an attempt is made to split the scarred and obliterated commissures. Usually we have

been able to accomplish this quite readily first laterally then medially The nature of the stenosed valve varies greatly (see Frontispiece) No two are alike Occasionally the valve s diameter cannot be increased by finger fracture alone in these instances a valvulotome of one type or another is used to increase the area of the orifice at the line of the presumed commissure Our object is to create a valve area of from four to six square centimeters with minimal regurgitation The mobility of the leaflets determines to a considerable degree the efficiency of the valve It is desirable to gain a wide separation between the leaflets both medially and laterally This usually requires five or six attempts when the finger alone is used In our experience the results have demonstrated that 90 per cent of valve orifices can be sufficiently enlarged by finger fracture

All of the valvulotomies were performed by Frank Glenn M D and his staff

POSTOPERATIVE CARE

1 Oxygen

Immediately postoperatively patients received oxygen by mask until they had completely reacted Thereafter oxygen was supplied by tent and maintained on the average of two days continuously then as dictated by the patient s color and dyspnea It was usually possible to discontinue oxygen completely after the fifth day

2 Treatment of left pleural effusion

Most of the patients (91) had an in-dwelling chest catheter connected to three bottle suction This drainage tube was usually removed between the second and fourth postoperative day as it was found not to be patent thereafter None of these patients required thoracentesis The initial nine patients had no such drainage and in some of these it was thought to be indicated because of excessive dyspnea or undue fluid accumulation recorded on the daily chest x ray

3 Antibiotics

With few exceptions patients received procaine penicillin 400 000 units intramuscularly and either dihydrostreptomycin or

streptomycin 0.5 gm. intramuscularly, twice daily, beginning the night before the operation. These drugs were continued for six to eight days, but occasionally up to three weeks if the patient remained febrile. Broad spectrum antibiotics were substituted in patients allergic to penicillin.

4. Analgesia

Demerol 25 to 75 mgm. intramuscularly or morphine 5 to 8 mgm. subcutaneously were used for initial analgesia, being given every three to four hours as necessary. Codeine 65 mgm. subcutaneously was often substituted after the first two to three days. Significant need for analgesia did not exist beyond the fifth to sixth postoperative day in most patients. A few with especially severe or prolonged incisional pain were treated with paravertebral block with varying success.

5. Food and fluid intake

For the first three to five postoperative days patients were kept on a low salt and low fluid intake and were then progressed as tolerated to a low salt (1.0 to 3.0 gm.) general diet. Infusions were rarely necessary, as nearly all patients were able to start fluids by mouth the night of the operation and to maintain an adequate postoperative intake thereafter. Fluids were usually limited to 1500 to 2500 cc. during the first three to four postoperative days, but thereafter in most patients were allowed as desired.

6. Cardiac medications

Digitalis was continued in preoperative dosage or as dictated by the rate of auricular fibrillation or the occurrence of an auricular arrhythmia. Mercurial diuretics were given to only a few patients, namely to those who developed significant ankle, sacral or pulmonary edema. Quinidine was used solely in attempts at reversion of auricular fibrillation to normal rhythm (p. 36).

7. Therapy of postoperative arrhythmias

Postoperative paroxysmal auricular fibrillation or auricular flutter was treated with control of the ventricular rate by a digitalis preparation, usually lanatocide D. Then, when the

patient was afebrile attempt at conversion to normal rhythm with quinidine was made provided there was no history of recent emboli no great cardiac enlargement and auricular thrombi had not been found at operation Digitalis was withheld on the days of attempted conversion and the patient kept in bed Quinidine was given in divided doses totalling 1 4 to 1.5 gm. the first day and then increased gradually to a maximum of 4 gm in one 24-hour period If this dosage level did not achieve conversion the attempt was abandoned Following reversion to normal rhythm quinidine was kept up in small dosage (0 2 gm t i.d) for two to three days and then stopped

One instance of coupled rhythm with ventricular premature contractions was treated successfully with pronestyl There were no cases in which paroxysmal ventricular tachycardia occurred

8 Treatment of embolic phenomena

Anticoagulants have not been used routinely as an adjunct to mitral valvulotomy as we wished to be able to assay the effect of valvulotomy alone uninfluenced by this form of therapy In patients who had had recent pulmonary infarction and in whom Dicumarol was being used before operation this therapy was discontinued before operation and in most instances was not reinstituted

Patients with clear-cut pulmonary emboli developing postoperatively were treated with anticoagulants Long term anticoagulant therapy was embarked on in one patient who had repeated pulmonary emboli postoperatively one who had been on such treatment preoperatively for repeated emboli and one who sustained a cerebral embolus at the time of operation

9 Treatment of tracheo-bronchial secretions

Coughing proved the best mode of handling secretions and was actively encouraged several times daily with assistance from the staff in attendance Oxygen tents with high moisture atmosphere were frequently employed and in some cases continuous Alevaire spray was introduced into the tent Neither of these maneuvers proved especially effective One patient had such difficulty raising mucus that tracheotomy was performed during

the first postoperative week Another, who had left recurrent laryngeal palsy preoperatively, had prophylactic tracheotomy performed immediately following valvulotomy More recently the intermittent positive pressure Bennett respirator (with either Alevaire or pancreatic dornase) has been used postoperatively Patients were trained before operation to use this apparatus

10. Ambulation

Ambulation was started when the patient was afebrile, usually at the end of the first postoperative week The average duration of postoperative hospitalization was two to three weeks Most patients were discharged directly home, a few going first to convalescent homes They were instructed to lead an extremely sedentary life the first two weeks home, and thereafter were graded up to tolerated activity over a period of several weeks

11. Follow-up

Patients were seen in our Cardiac Clinic one to three weeks after discharge They were followed thereafter at monthly intervals until maximum activity was resumed and are still being seen every one to six months, depending on their status and place of residence

Section II

CLINICAL MATERIAL

INTRODUCTION

The first 100 patients selected for mitral valvulotomy by us consisted of 75 females and 25 males who came to operation in 1951 1952 and 1953 They ranged in age from 18 to 56 with 42 between 30 and 40 years Ninety of these patients have been followed for periods from three to 36 months and results attributable to the operation have been evaluated and classified according to the categories of improvement discussed in Page 17 Of the remaining 10 patients three died during the operation or in the postoperative period while still in the hospital Four patients were surgically explored and no definitive procedure was done One of these four died during the immediate postoperative period One was lost to follow up The information and opinions about the remaining two patients are conflicting so that it seemed best to set them aside in order not to weight in either direction those in whom the results were more apparent. Five of the 90 patients were pregnant and are considered separately (p 48) leaving 85 for study and evaluation as a group The results in these 85 patients who had a mitral valvulotomy form the basis of this analysis

CLASSIFICATION OF PATIENTS ACCORDING TO THE CRITERIA OF THE NEW YORK HEART ASSOCIATION AND GRADING OF IMPROVEMENT AFTER MITRAL VALVULOTOMY

All patients were graded according to the classification of the New York Heart Association both before and after operation Our analyses as to the grade of improvement were made using these criteria

1 *2 plus or marked improvement* These patients are asymp-

tomatic on moderate activity and some have returned to normal activity They require no diuretic therapy Some patients in this category remain on a low salt diet Certain patients exhibiting normal rhythm and all with auricular fibrillation continued to take digitalis All these patients were on low salt diet or digitalis preoperatively

2 *1 plus or moderate improvement* These patients had their symptoms (dyspnea, orthopnea, edema and/or hemoptysis) improved but not abolished Some symptoms persist on moderate activity A few of these patients require diuretic therapy Most are observing the same or less strict cardiac regimen than preoperatively Some are on digitalis and a low salt diet and a few require mercurials In these cases the stricter postoperative regimens were considered insufficient to account for the degree of improvement observed

3 *0 improvement* These patients showed essentially no change in their cardiac signs and symptoms on the same, less strict, or stricter regimen than preoperatively All patients are on digitalis and some need diuretic therapy

4 *Worse* These patients postoperatively had more severe cardiac signs and/or symptoms

All of the pertinent data of each patient were transferred to a large card These data were then summarized on a large table from which the analyses were made

The over-all results of the operation in each patient were independently evaluated by two observers and they usually agreed Where there was any divergence of opinion on the first evaluation, the data were reviewed, the patient perhaps seen again, and the result re-evaluated

PREOPERATIVE DIAGNOSIS AS TO VALVULAR INVOLVEMENT

(With comments on pure mitral stenosis and pure mitral insufficiency)

Fifteen patients had pure mitral stenosis, but one of these also had pure tricuspid stenosis diagnosed before operation, the mitral stenosis being operated first and later the tricuspid stenosis (Table 1)

TABLE 1

PREOPERATIVE VALVULAR DIAGNOSIS IN 85 PATIENTS

Valve	*Number of Patients*
M S only	15
M S predominating: M I sl.	44
M S predominating: A I	4
M S predominating: M I sl A I sl	5
M S predominating: M I sl., A S sl., A I sl	3
Patients with Tricuspid Insufficiency: (14 pts)	
M S predominating: T I sl	1
M S predominating: M I sl., T I sl	10
M S predominating: M I sl., A S sl T I sl	1
M S predominating: M I sl., A. S sl A I sl T I sl	1
M S predominating: M I sl T S sl T I sl	1
Total	85

The largest group was that of predominant mitral stenosis with slight mitral insufficiency namely 44 patients

Four patients with predominant mitral stenosis also had slight aortic insufficiency

Five patients in addition to predominant mitral stenosis had slight mitral and also aortic insufficiency

Three patients in addition to predominant mitral stenosis had slight mitral insufficiency and also slight aortic stenosis and insufficiency

There were 14 patients with evidence of tricuspid insufficiency They all had predominant mitral stenosis The largest group of 10 patients in addition to mitral stenosis had slight mitral insufficiency and slight tricuspid insufficiency In three patients with tricuspid insufficiency there was one patient with predominant mitral stenosis one with slight mitral insufficiency and aortic stenosis and insufficiency added and one with slight mitral insufficiency and slight tricuspid stenosis

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In this table and in those following:
M S = mitral stenosis
M I = mitral insufficiency
A S = aortic stenosis
A I = aortic insufficiency
T S = tricuspid stenosis
T I = tricuspid insufficiency
P I = pulmonary insufficiency
sl = slight

In the 85 patients in this analysis there were 69 women and 16 men Of the 69 women, 14 had "pure" mitral stenosis by physical examination In 12 of these this was confirmed at operation, while the two others were found to have some degree of mitral insufficiency Four of the 69 women were found to have "pure" mitral insufficiency at operation

In three of the 16 men, "pure" mitral stenosis was clinically diagnosed preoperatively All three were found to have some mitral insufficiency at operation No male patient had "pure" mitral insufficiency at operation

Thus, in this series there was no case of "pure" mitral stenosis or "pure" mitral insufficiency in men

AGE OF PATIENTS

The age of the 100 patients ranged from 18 to 56 years, most being in the fourth and fifth decades (Fig 1) There was only one patient in the second decade, one of those who came to operation while pregnant There were 17 patients in the third decade, 41 in the fourth decade, 36 in the fifth decade, and five in the sixth decade

About three-quarters of the patients were female The age and sex incidence is that commonly found in other studies of rheumatic heart disease and is similar to that in the second 200 patients

MORTALITY

There were three deaths in the first 100 patients in the first month after operation Two of these may be attributed to the operation One patient (Case No 83, A B , N Y Hospital Hist No 602805) died on the table of cardiac arrest following ventricular fibrillation which could not be terminated He was operated on because of his downhill course and symptoms even though we had made a diagnosis of aortic stenosis, mitral insufficiency and tricuspid insufficiency preoperatively, and in full realization of the grave risk At operation the mitral insufficiency was more marked than the mitral stenosis Permission for autopsy was not granted

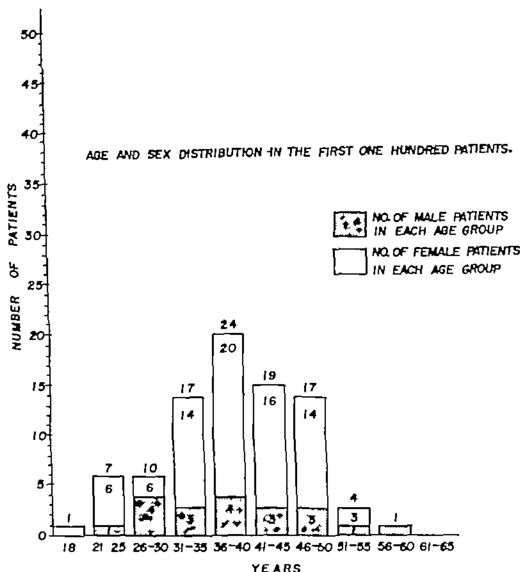


Figure 1 In this figure are shown the age and sex distributions of the first one hundred patients on whom mitral valvulotomies were performed

Another patient (Case No 4 J T N Y Hospital Hist No 353830) died on the third day after operation This patient had a satisfactory split there were no thrombi in the left auricle but he had signs of cerebral embolism (weakness of right face and arm) postoperatively and never fully reacted after operation being comatose and in marked dyspnea The valve was markedly calcified and a piece of calcium may have broken off Permission for autopsy was not granted

A third patient (Case No 8, R D , N Y Hospital Hist No 500572) died 23 days after operation probably of a cerebral accident This patient had aortic stenosis, aortic insufficiency, mitral stenosis and mitral insufficiency and had had cerebral accidents and pulmonary infarctions before operation Both she and the family insisted that the operation be undertaken as a last measure At operation the mitral valve would admit only the index finger tip and there was mitral insufficiency Little was accomplished because the valve was calcified and there was the hazard of increasing the insufficiency After slight enlargement of the valve orifice the index finger could be inserted. The patient had an uneventful immediate recovery and was ambulatory She died suddenly on the 23rd postoperative day At autopsy (Table 2) there were numerous thrombo-emboli in the heart, kidneys, pancreas and spleen There was a split in the valve of approximately 5 mm There was an area of early softening in the brain The estimation of mitral insufficiency on clinical examination was given weight by the prediction on the basis of catheterization and confirmed at operation This patient's course did not appear to be aggravated by operation

There remains a 2 per cent mortality rate, or at most 3 per cent if the last mentioned patient is included, in our first 100 patients subjected to mitral valvulotomy

No patients died during the follow-up period of three to 36 months in these first 100 cases

PATIENTS WHO HAD A THORACOTOMY OR CARDIOTOMY WITHOUT OPERATION ON THE MITRAL VALVE

Four patients fell into this category The first (Case No 39, F S , N Y Hospital Hist No 614449), a 24 year old woman, was subjected to operation because of exertional dyspnea Preoperative clinical diagnosis was mitral stenosis, mitral insufficiency, and either pulmonic or aortic insufficiency The left auricle was entered at operation and moderate mitral stenosis with marked mitral insufficiency was felt by the surgeon Operation on the valve was not performed and the patient was unchanged after-

TABLE 2

THE ONE OPERATIVE DEATH ON WHOM AN AUTOPSY WAS PERFORMED

Case No. N. Y. Hospital History No.	Age Sex	Preoperative Classification	Reason for Operation	Preoperative Valvular Diagnosis	Mitral Valve at Operation	Complications at Operation	Time of Death after Operation	Postoperative Course	Reason for Death	Autopsy
Case No. 8 R. D. 500572	37 F	IV D	Dyspnea, hemoptysis, cerebral and pulmonary infarcts	M. S. M. I. A. S. A. I.	Much calcification, some M. I. Before split the orifice barely admitted finger tip. After split finger could pass through valve. M. I. increased.	None	23 days	Arrhythmias: Auricular fibrillation and flutter. Reverted to N. R. on 11th postoperative day. Only digitalis used. BUN rose to 116 mgm. % then fell to 33 mgm. % (preoperative level). Toxic delirium. Left sided weakness and aphasia noted before death. Cardiac failure not problem. Fairly sudden death.	Multiple emboli	Markedly distorted and calcified mitral and aortic valves. Thrombi of polymorphonuclear cells and platelets on free margin of both valves. Minor thickening of tricuspid valve. Right ventricle 4-5 mm. in thickness. Thrombosis at site of resected auricular appendage; congestion of lungs, liver, spleen. Right pleural fluid. Emboli in arterioles of myocardium, lung, kidney, pancreas, bone marrow, spleen, periadrenal fat. ?rheumatic endarteritis in kidney. Brain: fibrous thickening of capillary walls in cortex and small scar. One area of early softening.

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No patients died during the follow-up period of three to 36 months in these first 100 cases

PATIENTS WHO HAD A THORACOTOMY OR CARDIOTOMY WITHOUT OPERATION ON THE MITRAL VALVE

Four patients fell into this category The first (Case No 39, F S, N Y Hospital Hist No 614449), a 24 year old woman, was subjected to operation because of exertional dyspnea Preoperative clinical diagnosis was mitral stenosis, mitral insufficiency, and either pulmonic or aortic insufficiency The left auricle was entered at operation and moderate mitral stenosis with marked mitral insufficiency was felt by the surgeon Operation on the valve was not performed and the patient was unchanged after-

TABLE 2

THE ONE OPERATIVE DEATH ON WHOM AN AUTOPSY WAS PERFORMED

Case No. N Y Hospital History No.	Age Sex	Preoperative Classification	Reason for Operation	Preoperative Valvular Diagnosis	Status of Valve at Operation	Complications at Operation	Time of Death after Operation	Postoperative Course	Reason for Death	Autopsy
Case No. 8 R. D. 500572	37 F	IV D	Dyspnea, hemoptysis, cerebral and pulmonary infarcts	M. S. M. I. A. S. A. I.	Much calcification, some M. I. Before split the orifice barely admitted finger tip. After split finger could pass through valve. M. I. increased.	None	23 days	Arrhythmias Auricular fibrillation and flutter Reverted to N. R. on 11th post operative day Only digitalis used. BUN rose to 116 mgm. % then fell to 33 mgm. % (preoperative level) Toxic delirium. Left sided weakness and aphasia noted before death. Cardiac failure not a problem. Fairly sudden death.	Mul ple emboli	Markedly distorted and calcified mitral and aortic valves. Thrombi of poly morphonuclear cells and platelets on free margin of both valves. M nor thickening of tricuspid valve. Right ventricle 4.5 mm. in thickness. Thrombosis at site of resected auricular appendage; congestion of lungs, liver spleen. Right pleural fluid. Emboli in arterioles of myocardium, lung, kidney pancreas, bone marrow spleen, periadrenal fat. ? rheumatic endarteritis in kidney Bra fibrous thickening of capillary walls in cortex and small scar. One area of early softening

wards The severity of the mitral insufficiency had not been appreciated preoperatively

The second patient was a 49 year old woman (Case No 47, K M, N Y Hospital Hist No 647330) who was operated on because of exertional dyspnea and easy fatigability The preoperative clinical diagnosis was mitral stenosis and mitral insufficiency At operation the left auricle could not be entered because of an adherent pericardium, an indurated, thickened and friable left auricular wall and a shrunken auricular appendage. The patient's status was unchanged by operation

The third patient (Case No 70, A F, N Y Hospital Hist No 649047) was a 44 year old man in whom operation was performed because of progressive increase in dyspnea and easy fatigability The preoperative clinical diagnosis was mitral stenosis, mitral insufficiency, and tricuspid insufficiency At operation a large calcified clot filled the left auricle and the procedure was abandoned Although the patient claimed he felt better, objective criteria were unchanged by the operation

The fourth patient (Case No 81, J J, N Y Hospital Hist No 663606), a 31 year old man, was classified IV D preoperatively because of severe exertional dyspnea and massive hemotysis Preoperative diagnoses were mitral stenosis and insufficiency At operation a vestigial auricular appendage was found with distortion of the adjacent left coronary artery The procedure was abandoned and the patient died in severe congestive failure and terminal shock on the 20th postoperative day

Accordingly, one of the four patients in this category died in the immediate postoperative period The other three patients remained alive during the period of follow-up

Section III

EVALUATION OF RESULTS IN THE 85 PATIENTS WHO HAD MITRAL VALVULOTOMIES AND SURVIVED THE IMMEDIATE POSTOPERATIVE PERIOD

OVER ALL RESULTS IN 85 PATIENTS WITH RESPECT TO BENEFIT

Benefit was gauged by the degree of improvement in the patients presenting complaints and improvement in those manifestations for which it was deemed wise to do the valvulotomy namely: ability to walk, to do housework to return to their usual activities or to normal activities improvement in heart failure cessation of embolic phenomena fatigue etc Improvement was graded as we have indicated as *two plus* or *marked improvement* and *one plus* or *moderate improvement* In the marked improvement group were those so greatly improved that they returned to completely normal activity as well as those who did not attain this maximal degree but were able to return to work etc. Those moderately improved had detectable benefit in objective and subjective manifestations In these analyses the number of patients in some categories is small Nevertheless the trends are apparent (Table 3)

Of the 85 patients 35 or 41 per cent were *markedly* improved (++) 26 or 31 per cent were moderately improved (+) Fifteen or 17 per cent of the patients showed *no change* in their status after operation three patients *first improved* but then reverted to their preoperative status one patient first improved and then became worse than before operation one patient had no immediate change after operation and then later became worse and four patients were definitely worse after operation

In short 72 per cent of the patients were benefited by

TABLE 3

OVER-ALL RESULTS WITH RESPECT TO BENEFIT IN 85 PATIENTS AFTER MITRAL VALVULOTOMY

*Grade of Improvement**	*Number of Cases*	*Percent of Total Improved*
Markedly Improved	35	41
Moderately Improved	26	31
Unchanged	15	17
Improved going to Unchanged	3	4
Improved going to Worse	1	1
Unchanged going to Worse	1	1
Worse at once	4	5
Total	85	100

*For method of grading improvement see Part I, p 17

operation, 41 per cent markedly (35 patients) and 31 per cent moderately (26 patients), 21 per cent (15 + 3 patients) might expect no improvement, and in 7 per cent (six patients) the end result was that the patients were worse

IMPROVEMENT WITH RESPECT TO NEW YORK HEART CRITERIA FOR CLASSIFICATION

There were 85 patients in this analysis (Table 4)

No patients in Class I were operated upon

Five Class II patients were operated, two being markedly and two moderately improved and one made worse Some degree of improvement was shown by 80 per cent of the patients

Sixty-seven Class III patients were operated, 29 were greatly improved, 20 moderately so and 13 unchanged, and five with temporary improvement worsened A total of 73 per cent (29 + 20 patients) showed some improvement

Thirteen Class IV patients were operated, four were greatly improved, four moderately, two unchanged and three temporarily improved or worsened A total of 61 per cent (4 + 4 patients) showed some improvement

TABLE 4

IMPROVEMENT WITH RESPECT TO NEW YORK HEART CRITERIA FOR CLASSIFICATION

Grade of Improvement	*Class I*	*Class II*	*Class III*	*Class IV*	*Total in all Classes*
++	0	2	29	4	35
+	0	2	20	4	26
0	0	0	13	2	15
+ → 0	0	0	2	1	3
+ → W	0	0	1	0	1
0 → W	0	0	1	0	1
W	0	1	1	2	4
Total No of Cases	0	5	67	13	85

See Part I p 17

+ W = worse

Although the Class II group was small 80 per cent of them had some degree of improvement. In Class III (which comprised the largest group operated) 73 per cent had improvement in Class IV thirteen patients were operated 61 per cent of whom were improved Although the number of patients in Classes II and IV are small it appears that the opportunity for improvement decreased as the severity of the disease increased

IMPROVEMENT AND RHYTHM

Forty-one of the 85 patients had normal sinus rhythm at the time of operation and 44 auricular fibrillation

Eighteen patients or 43 9 per cent of those with normal rhythm and 17 patients or 38 6 per cent of those with auricular fibrillation were greatly improved Thirteen patients or 31 7 per cent with normal rhythm and 13 or 29.5 per cent of those with auricular fibrillation were moderately improved Those without change were only four or 10 per cent in normal rhythm but were 11 patients or 25 per cent of those with auricular fibrillation

Of the miscellaneous group who improved and then regressed or were worse there were five patients with normal rhythm

and one with auricular fibrillation One patient with normal rhythm was made worse by operation, and two with auricular fibrillation

It appears, therefore, that the chances of marked or moderate improvement are slightly greater (76 per cent) in patients with normal rhythm (44 per cent + 32 per cent) than in patients with auricular fibrillation, namely 69 per cent (39 per cent + 30 per cent) Moreover, more patients with auricular fibrillation were unimproved as a result of operation

Seven of the patients in the normal rhythm group who improved had changed to auricular fibrillation at the time of the last follow-up, while only two of those with auricular fibrillation had reverted spontaneously to normal rhythm

IMPROVEMENT AS TO SEX

Sixty-nine of 85 patients were females and 16 were males, approximately a 4 1 ratio

Of the 69 women 30, or 43 5 per cent, were markedly improved while five of 16 males, or 31 3 per cent fell in this category Twenty-two of the women, or 31 9 per cent, were moderately improved, while four, or 25 per cent of the males fell in this category Eleven, or 15 9 per cent of the females were unchanged, while this was true of four, or 25 per cent of the males There was no marked difference in the two sexes in those made worse by operation It appears that the chances of some degree of improvement following operation are definitely greater in women than in men, being 75 3 per cent (44 per cent + 32 per cent) for women and 56 9 (31 per cent + 25 per cent) for men

IMPROVEMENT AS TO AGE

A total of 85 patients were analyzed for improvement versus age There were no patients in the 10 to 20 years old age group and the results of the analysis are presented in Table 5 There was no marked difference in operative result in the various age groups

PRESENTING SYMPTOMS AND IMPROVEMENT

Fifteen patients had attacks of pulmonary edema as one of their presenting manifestations Ten, or 66 6 per cent of these were in the greatly improved group, three in the moderately improved and one in the unimproved One was worse after

TABLE 5

IMPROVEMENT AND AGE

Grade of Improvement	21-30 Years	31-40 Years	41-50 Years	51-60 Years
	Per Cent	Per Cent	Per Cent	Per Cent
++	50.0	33.3	50.0	20
+	33.3	36.3	18.9	60
0	0.0	19.4	21.8	20
+ → 0	0.0	5.5	3.1	0
+ → W	8.3	0.0	0.0	0
0 → W	0.0	0.0	3.1	0
W	8.3	5.5	3.1	0
Total number of cases	12	36	32	5

See Part I p 17
+ W = worse

operation In short 13 or 87 per cent were improved

Twenty-one patients had pulmonary embolism as a presenting manifestation Seven or 33 per cent were in the greatly improved group and nine or 43 per cent in the moderately improved group Three were unimproved and none made worse A total of 16 or 75 per cent were improved

Seventeen patients had peripheral emboli before operation Seven or 41 per cent after operation fell in the greatly improved group 6 or 35 per cent in the moderately improved group three were unimproved and one was worse Thirteen patients or 76 per cent were accordingly improved

Sixty-eight patients had progressive dyspnea as a presenting symptom Twenty nine or 41 per cent were greatly improved 22 or 32 per cent were moderately improved In 11 patients or 16 per cent this symptom was not improved and three finally were worse A total of 51 patients or 73 per cent were improved of dyspnea

Twenty five patients had progressive easy fatigue as a presenting symptom Eight patients or 32 per cent were greatly improved 10 or 40 per cent were moderately improved and three were

finally unimproved Accordingly a total of 18, or 72 per cent of the patients with this symptom fell in the group with some improvement

Twenty-one patients had hemoptysis as a presenting symptom Seven patients, or 33 per cent were in the greatly improved group, six patients or 29 per cent were moderately improved, five fell in the unimproved group and two in the "worse" group A total of 13, or 62 per cent fell in the improved group

The results of operation with respect to embolic phenomena will be analyzed in another section of this report

IMPROVEMENT AND PREOPERATIVE DIAGNOSIS OF VALVE LESIONS

In 78 of the 85 patients it was possible to make an estimate of improvement with relation to the preoperative murmurs No patients with wide open aortic insufficiency were operated upon

Thirteen patients had pure mitral stenosis (without other valve murmurs) Seven, or 53 8 per cent were markedly improved Four, or 30 9 per cent of the patients were moderately improved, two were unimproved and none made worse In short 11 patients (7 + 4) or 84 6 per cent had some improvement

Thirty-nine patients had predominant mitral stenosis with some degree of mitral insufficiency (but not marked clinically) Sixteen patients or 41 per cent were markedly improved and 10, or 25 6 per cent moderately improved Eight patients or 20 5 per cent had no change Twenty-six patients (16 + 10) or 66 6 per cent accordingly had some improvement

The presence of a moderate degree of aortic insufficiency with pure mitral stenosis or with mitral stenosis and mitral insufficiency did not depress the degree of benefit markedly since three (one marked, two moderate) of four patients in the former category (75 per cent) and four of five patients (80 per cent) in the latter had benefit, all four of the latter showing marked benefit

Only three patients with definite aortic stenosis were operated in this group of 78 and only one was improved

Fourteen patients had tricuspid insufficiency in addition to mitral stenosis and other valvular involvement Nine or 64 3 per

cent of these showed improvement (two marked improvement seven moderate)

It appears that patients with pure mitral stenosis have the most benefit from operation and the presence of moderate aortic in sufficiency does not influence the results unfavorably or even moderate aortic insufficiency in the presence of mitral stenosis and mitral insufficiency provided other valve lesions are not present. There were five cases only in this group four being greatly improved and in one the condition remaining unchanged

On the other hand the presence of mitral insufficiency with mitral stenosis decreased the number benefited by operation as did the presence of tricuspid insufficiency

Diagnosis of mitral insufficiency of clinical importance was based on presence of a harsh rough systolic murmur transmitted to the axilla addition of a systolic thrill presence of left ven tricular enlargement in x ray and on fluoroscopy absence of right axis deviation and right ventricular hypertrophy in the electrocardiogram in the presence of the mitral stenosis (or less than to be expected for the degree of mitral stenosis which was postulated from the over-all evaluation) or the presence of left ventricular hypertrophy pattern in electrocardiogram and history of fatigue as a predominant symptom

ASCHOFF BODIES IN LEFT AURICULAR APPENDAGE AND IMPROVEMENT

Eighty three of the 85 patients had biopsy report of the presence or absence of Aschoff bodies in the left auricular appendage re moved at operation

Eighteen of these 83 patients were positive for Aschoff bodies namely an incidence of 20 per cent while 80 per cent were negative

Six of the 18 patients, or 33 per cent, with positive Aschoff bodies were greatly improved and five or 28 per cent moderately improved a total of 61 per cent accordingly showed some im provement Seven patients did not change or were not made worse

Of the 65 patients in whom the biopsy was negative for Aschoff bodies 28 patients or 43 per cent, were greatly improved 20

patients, or 31 per cent, were moderately improved. Thus 48 patients, or 74 per cent, had some improvement Seventeen patients had no improvement, or were made worse

Therefore, it appears that activity of infection as judged by the presence of Aschoff bodies reduces the chance for improvement from 74 per cent in the no Aschoff body group to 61 per cent when Aschoff bodies are present The results in the analysis in the second two hundred patients differs from this estimation (Part II, Section III, page 99)

IMPROVEMENT AND ESTIMATED SIZE OF MITRAL VALVE AT OPERATION

In eighty-three patients statements were made about the size of the mitral orifice at operation Patients were considered to have a *"tight"* mitral stenosis if it* was estimated at 1 0 or less than 1 0 sq cm in area Moderate stenosis was more than 1 0 sq cm in area but less than 2 0 sq cm *Little or no critical stenosis* was postulated if its size was estimated at equal to or more than 2 sq cm

Seventy-three patients had "tight" mitral valves Thirty-two, or 43 8 per cent of these had marked improvement, 23 or 31 5 per cent had moderate improvement, 11 or 15 per cent had no improvement, three additional patients improved, but later regressed to their original status, and four were finally worse Accordingly, a total of 55 patients (75 per cent) with "tight" mitral valves had some degree of improvement

There were seven patients with moderate stenosis, two of them were greatly improved, two moderately improved, a total of four, or 57 per cent, therefore, had some degree of improvement, while two remained unchanged and one was worse

Two patients with little or no stenosis were unimproved. One patient was made worse by operation, this patient had mitral stenosis with marked mitral insufficiency at operation

* All valves were examined at operation by one of us (J G) If the orifice admitted only the tip of the index finger it was estimated as less than 1 sq cm [illegible] if the finger could be inserted one half way to the joint it was estimated as being between 1 and 2 sq cm area and if it admitted the joints 2 sq cm

It appears therefore that patients with tight mitral valves have the best chance of improvement from operation and less chance of having their condition worsened

IMPROVEMENT AND ESTIMATED ADEQUACY OF OPERATIVE SPLIT

In 83 of the patients estimates of the adequacy of operative split were clearly stated in the operative notes

Sixty two patients with tight mitral stenosis had what was estimated by the surgeon as a satisfactory split of the mitral valve Thirty patients (48 per cent) were greatly improved twenty (32 per cent) were moderately improved eight were un improved and two finally worse Accordingly a total of 80 per cent of the patients in this group had some improvement. There were 11 patients with tight mitral stenosis in whom little or no split was estimated to have been accomplished Two of these patients were greatly improved three moderately so three un improved and two finally worse and one worse right after the operation

There were three patients with moderate stenosis who had satisfactory splits one was very much improved one remained unchanged and one was made worse There were four patients with moderate stenosis in whom it was estimated that a good split had not been accomplished one of them was markedly improved two moderately and one remained unchanged

There were three patients at operation who had little or no stenosis and in whom little or no split was accomplished two of these remained unchanged and one was worse after operation

As one would expect the improvement was most marked and more likely to result in patients with tight mitral stenosis in whom a good split was accomplished in this group 80 per cent may expect some improvement.

In summary there were 65 patients in all groups who had satisfactory splits 31 patients (48 per cent) were greatly improved and 20 patients (31 per cent) were moderately improved Nine patients (14 per cent) were unimproved and three were finally worse In short, 51 (78 per cent) of the patients in whom good splits were accomplished had good results

The valvulotome knife was used in nine patients two were markedly improved, four moderately improved, one unchanged, and two worse

IMPROVEMENT AND CALCIFICATION IN THE MITRAL VALVE

In the operative notes relating to these 85 patients statements about calcification in the mitral valve were made in 79 of them in the following terms "No calcification" was detected, "marked calcification," and "slight or moderate calcification "

There were 15 patients with marked calcification Four (26 6 per cent) of these were markedly and five (33 3 per cent) moderately improved, in short, 60 per cent of these patients showed some improvement Two of them were made worse

There were 46 patients with moderate or slight calcification 21 (45 6 per cent) were markedly and 13 (28 3 per cent) moderately improved, while 6 (13 per cent) had no change in their status In short, 34 patients (21 + 13) or 74 per cent of those with slight calcification had some degree of improvement

Eighteen patients had no calcification eight (44 per cent) had marked improvement, five (27 7 per cent) were moderately improved, and in five, or 27 7 per cent, there was no change Accordingly, 13 patients (8 + 5) or 72 2 per cent without calcification showed some improvement

It appears that patients with marked calcification have slightly less chance of being improved, but those with moderate calcification were as likely to have a good result as those with no calcification

Seven of the 14 men in the group of 79 patients under discussion (50 per cent) had marked calcification, and six of them had moderate or slight calcification It is apparent that 93 per cent of the men in the series had some degree of calcification of the mitral valve detected at operation On the other hand, only eight (12 3 per cent) of the 65 women in the group had marked calcification, 39 (60 per cent) had moderate calcification, and 17 (26 1 per cent) had no calcification

RELATION OF MITRAL INSUFFICIENCY FOUND AT OPERATION AND ITS INCREASE OR LACK OF CHANGE BY OPERATION TO IMPROVEMENT

It was possible to analyze 77 patients from the point of view of the relation of the degree of mitral insufficiency detected at operation and its increase or lack of change by valvulotomy to improvement Thirty six patients (47 per cent had no mitral insufficiency detected by a regurgitant stream at operation nor was mitral insufficiency induced at operation by splitting the valve 20 of these (56 per cent) were greatly improved and nine (25 per cent) moderately improved making an over all improvement in 29 patients (81 per cent) Four patients were unchanged by the operation and only one made worse

Three patients had no mitral insufficiency detected at operation but had mitral insufficiency created by splitting One of these patients was greatly and two moderately improved by the procedure

In 21 patients slight to moderate mitral insufficiency could be detected during finger exploration of the valve and after valvulotomy the degree of mitral insufficiency was unchanged or decreased Ten (48 per cent) of these patients were greatly and five (24 per cent) moderately improved making a total of 72 per cent improvement rate Five other patients were finally unchanged in their status and one was made worse

There were seven patients with moderate mitral insufficiency detected at operation and its extent was increased by valvulotomy One of these patients was greatly and four moderately improved an over-all rate of 71 per cent improvement The status of one patient remained unchanged and one was finally worse

Five patients were estimated to have marked mitral insufficiency at operation the degree of which was unchanged or decreased after splitting the valve Two of these patients were markedly improved two remained unchanged and one became worse

There were five patients with marked mitral insufficiency at operation and in them the regurgitant stream was increased by the procedure Two of these patients had moderate improvement two remained unchanged and one became worse

It appears that the best results with respect to improvement and also with respect to not worsening the patient's condition were secured in those patients who had no mitral insufficiency at operation and in whom it was not induced, the next best results were secured in those who had only slight or no mitral insufficiency beforehand and in whom slight insufficiency might be induced at operation if it was not present, or might be unchanged or decreased The over-all results with respect to maximal improvement were less in those in whom the mitral insufficiency was definitely increased by operation The results were poorest in those who had marked mitral insufficiency at operation especially if the mitral insufficiency was increased by the procedure

From another point of view there were 34 patients who showed marked improvement and in only two of these was mitral insufficiency increased or created by operation There were 22 patients sustaining moderate improvement and in eight of these mitral insufficiency was increased or produced by operation Thus it may be said that in 77 patients there were 15 (3 + 7 + 5) who sustained an increase in an already existing insufficiency, or in one mitral insufficiency was produced in the course of the operation

POSTOPERATIVE CARDIAC IRREGULARITIES

In fifty-six of the first 100 patients operated for mitral stenosis, auricular fibrillation was present before operation Two of these reverted spontaneously to normal rhythm postoperatively while on digitalis The remaining forty-four patients had normal sinus rhythm before operation In twenty of these patients (45 per cent) normal rhythm was replaced by auricular fibrillation after operation In one patient, Case No 97 (E F, N Y Hospital History No 650794) auricular paroxysmal tachycardia replaced normal rhythm Of the 20 patients in whom auricular fibrillation appeared, 14 reverted to normal rhythm, eight of these on digitalis only, five with quinidine added, and one patient who had two episodes of auricular fibrillation reverted to normal rhythm on one occasion with digitalis only and on the other required quinidine as well The latter is discussed below Six of the patients who

suffered auricular fibrillation postoperatively remained in this rhythm

In the patient (Case No 97 mentioned above) in whom auricular paroxysmal tachycardia occurred postoperatively this rhythm reverted to auricular fibrillation while on digitalis Auricular flutter then supervened Now on the administration of quinidine auricular fibrillation returned and persisted The patient continued to take digitalis

Three of the 20 patients in whom auricular fibrillation appeared postoperatively had unusual courses One patient, Case No 92 (C P N Y Hospital History No 668518) had two episodes of irregularity the first arrhythmia was auricular fibrillation which reverted to normal rhythm with the exhibition of quinidine. The other irregularity was auricular flutter which converted first to nodal rhythm and then to normal rhythm while the patient was on digitalis Normal rhythm persisted at the time of discharge from hospital

Another patient Case No 90 (M C. N Y Hospital History No 305481) in whom auricular fibrillation occurred reverted to normal rhythm with the use of quinidine Auricular fibrillation recurred and was again reverted to normal rhythm with the administration of quinidine In another patient, Case No 85 (H M N Y Hospital History No 666402) who before operation exhibited normal rhythm auricular flutter occurred postoperatively which reverted to auricular fibrillation while the patient was on ouabain Auricular flutter recurred when ouabain was discontinued Now with the use of digitalis auricular fibrillation was restored which was converted to normal rhythm by the use of quinidine.

EFFECT OF MITRAL VALVULOTOMY ON THE OCCURRENCE OF PULMONARY EMBOLI

Twenty two patients had histories of pulmonary infarction before operation 12 of whom had auricular fibrillation and 10 normal sinus rhythm There was apparently no significant difference in incidence of pulmonary emboli in the two rhythms Five of the 10 patients having auricular fibrillation and one

having normal rhythm had thrombus material in the left auricles at the time of operation

Of these 22 patients in whom histories of preoperative pulmonary emboli were obtained, three having auricular fibrillation and one having normal rhythm suffered arterial emboli at the time of operation One patient in whom the rhythm was auricular fibrillation had a hemiplegia Another patient had transient cardiac arrest at the time of operation when thrombus material entered the circulation, cardiac beats were reestablished and the patient had no evidence of damage from the thrombus material, or from the cardiac arrest In a third patient having auricular fibrillation, pieces of calcium were lost in the circulation but gave rise to no detectable signs or symptoms One patient having normal sinus rhythm had a small thrombus to the left eye which gave rise to a small visual defect

Of the 22 patients who suffered pulmonary emboli preoperatively, four patients (two having auricular fibrillation and two normal rhythm) had pulmonary infarctions within the immediate postoperative period (up to one month) One of the patients having auricular fibrillation and one having normal rhythm were given dicoumarol for short periods after the pulmonary infarctions occurred

Only two of the 22 patients who had pulmonary infarctions preoperatively had them in the follow up period (that is to say, *after* the first month) one patient in whom the rhythm was normal had two episodes of pulmonary infarction four and six weeks after operation, and was transiently anticoagulated for each, after which dicoumarol was discontinued The second patient, exhibiting normal rhythm, had a transient cerebral episode at home six weeks after operation with complete recovery

The incidence of pulmonary infarcts as a presenting manifestation was apparently decreased by mitral valvulotomy

EFFECT OF MITRAL VALVULOTOMY ON THE OCCURRENCE OF ARTERIAL EMBOLI

Seventeen patients, 10 exhibiting auricular fibrillation and seven normal rhythm, had arterial emboli preoperatively as one of the manifestations of their illness A total of 27 episodes were

recorded 16 to the brain nine to the legs one to the spleen and possibly one to a kidney

Three of these patients two exhibiting auricular fibrillation and one normal rhythm had thrombus material in the left auricles at operation

Among the 17 patients with histories of preoperative arterial emboli there were two embolic episodes at operation One patient having auricular fibrillation suffered a left hemianopsia In a second patient exhibiting auricular fibrillation who has already been mentioned under pulmonary infarctions thrombus material entered the circulation during the course of operation and was followed by cardiac arrest the cardiac rhythm was restored and there were no untoward sequellae

Among the 17 patients pulmonary infarction occurred in two patients exhibiting normal rhythm in the postoperative period One of these patients who had multiple embolic phenomena (pul monary and systemic) before operation died 28 days after opera tion and autopsy showed infarction of varying ages in the brain kidneys and pancreas

Only one of these 17 patients with preoperative histories of arterial emboli had a pulmonary embolus in the follow up period There were *no arterial emboli* in the follow up period in the 17 patients who had before operation sustained them

It appears therefore that mitral valvulotomy affected favorably the incidence of arterial emboli in these patients who had experienced them preoperatively

SUMMARY OF EFFECT OF MITRAL VALVULOTOMY ON THE OCCURRENCE OF EMBOLIC PHENOMENA

The over all incidence of arterial emboli and pulmonary in farcts at operation in the immediate postoperative period and in the follow up period in 22 patients having pulmonary infarc tions before operation were three arterial with residua and five pulmonary infarctions

The over all incidence of arterial and pulmonary infarcts at operation in the immediate postoperative period and in the follow up period in 17 patients having arterial emboli preopera tively were one arterial with residua and two pulmonary infarc

tions (This excludes Case No 8 (R D, N Y Hospital History No 500572) who had emboli pre- and postoperative and died 23 days after operation, Table 2)

On the other hand, of nine patients who had no clinical embolic phenomena, either preoperatively or at operation, five had arterial emboli clinically and two had pulmonary infarctions after operation

It appears that mitral valvulotomy in the series of first 100 patients we are now reporting affected favorably the incidence of both pulmonary infarctions and arterial emboli in those who had suffered them before operation

EMBOLIC PHENOMENA POSTOPERATIVELY IN PATIENTS WHO HAD NOT HAD EMBOLI BEFORE OPERATION

Nine patients, in three of whom auricular fibrillation was present and in six normal sinus rhythm, and in whom histories of embolic phenomena before operation could not be obtained, sustained emboli postoperatively In none of the nine patients were thrombi found in the left auricle at the time of operation Two patients sustained arterial emboli at operation one, a patient exhibiting auricular fibrillation, had a cerebral embolus and died on the third postoperative day In the second patient a piece of calcium was freed in the circulation during operation, but gave rise to no symptoms and no after effects A flat x-ray photograph of the abdomen taken postoperatively showed a density which might have been this piece of calcium in the region of the right kidney Six patients, one exhibiting auricular fibrillation and five normal rhythm suffered emboli in the immediate postoperative period One patient in whom auricular fibrillation was present suffered a pulmonary infarction

The embolic episodes which were encountered in five patients exhibiting normal rhythm will now be discussed· Two patients had cerebral emboli with transient signs three hours and again 10 days after operation, one patient had a transient episode to the right leg 14 days after operation, two patients had pulmonary infarctions, one of them possibly resulting from thrombophlebitis In the latter patient an anticoagulant regimen was instituted for a short period

Two of these nine patients had emboli in the follow up period that is to say beyond the immediate postoperative hospital period One patient exhibiting auricular fibrillation had evidence of a saddle embolus five weeks postoperatively the signs and symptoms of which cleared with conservative therapy and a short regimen of anticoagulant therapy

One patient exhibiting normal rhythm had one embolus to the right leg 14 days postoperatively and a second one to the right popliteal artery one month after operation Anticoagulant therapy was not used This patient was moderately improved but died two years and 3 months postoperatively probably due to heart failure Autopsy was not obtained

The embolic episodes occurring in patients in whom normal sinus rhythm was present were not associated with transient arrhythmias

It appears from this experience that patients exhibiting normal rhythm who have not had emboli preoperatively and without evidence of thrombus material in the left auricle at the time of operation may be more likely to sustain embolic phenomena after operation than patients in whom auricular fibrillation prevails

THE INCIDENCE OF LEFT AURICULAR THROMBI AND OF POSTOPERATIVE EMBOLIC PHENOMENA

Fifteen of 89 patients (16 8 per cent) in the analysis exhibited clots in their left atria at the time of operation Eleven (73 3 per cent) of these had neither postoperative pulmonary nor arterial emboli One patient sustained a cerebral embolus at operation from which he made a good recovery Another patient had cardiac arrest on the operating table after a clot had escaped into the circulation Cardiac massage was successful in restoring the heart beat and the patient recovered In one patient who had a left auricular thrombus calcium from the valve was released into the circulation but untoward effects did not follow In one patient in whom on cardiotomy a large clot in the left auricle was en countered the mitral valve was not palpated

PATIENTS HAVING THROMBI IN THE LEFT AURICLE AT OPERATION WITHOUT HISTORIES OF EMBOLI PREOPERATIVELY WHO ALSO DID NOT HAVE EMBOLI AT ANY TIME AFTER OPERATION

Eight patients, all exhibiting auricular fibrillation, had thrombus material in the left auricle at the time of operation, but none of them sustained any evidences of embolization in the immediate postoperative period, nor during the long time follow up period Accordingly, the finding of thrombus material in the left auricle at operation did not appear to predispose these patients to postoperative emboli Nevertheless, the hazard is obvious *None* of these patients received anticoagulant therapy *either before or after* operation

DURATION OF POSTOPERATIVE FEVER

The duration of fever after operation in 94 patients was analyzed It varied from one to thirty-nine days, with an average duration of six and one-half days These figures are only approximate as some of the patients had fever spikes after subsidence of the major postoperative elevation Postoperative complications were frequently associated with secondary rises in temperature

FATE OF THE PREOPERATIVE MURMUR THOUGHT TO BE DUE TO AORTIC INSUFFICIENCY

The diagnosis of aortic insufficiency may be easily made in the presence of the appropriate murmur if the defect is marked enough to cause the systolic pressure to rise, and to give a low diastolic pressure and result in a wide pulse pressure and to give rise to left ventricular enlargement Weight may be given to the murmur as indicating this interpretation if unequivocal aortic stenosis is present In other instances with mitral stenosis the presence of a soft diastolic murmur along the left sternal margin transmitted downward raises the question whether the murmur might be a Graham-Steell murmur of functional pulmonic insufficiency

We have analyzed the fate of preoperative murmurs which were thought to indicate aortic insufficiency

In five patients who exhibited such murmurs preoperatively the

murmurs disappeared after operation The status of one of these patients was unchanged by operation and three patients were markedly and one moderately improved The murmurs in these patients might have been due to functional pulmonic insufficiency

The murmur was present and unchanged in nine patients both before and after operation Four of these patients were markedly and one moderately improved by operation In three the status was not changed and in one there was at first improvement with regression to the preoperative status

There were six patients who did not have murmurs of aortic insufficiency before operation but in whom the murmur was detected at some time after operation Only two of these patients exhibited what might have been some components of the post commissurotomy syndrome Two of them had been markedly and two moderately improved In one the status was first improved and then regressed to the preoperative status and in still another the status was unchanged by operation

It is our opinion that most of the patients in whom the diagnosis of aortic insufficiency was made had this organic defect in varying degrees and that the murmurs were not due to functional pulmonic insufficiency

POSTOPERATIVE COMPLICATIONS

The following are the major complications that occurred during the postoperative period

Chest pain, fever (?"Postvalvulotomy Syndrome"*)	14
Acute Rheumatic Fever	3
Arterial Emboli	7
Pulmonary Emboli	5 (with 4 more possible)
Pneumonitis	0
Atelectasis	5
Fever without definite diagnosis of cause	4
Thrombophlebitis	2
Pleural Effusion	2
Low Salt Syndrome	1
Pericardial Effusion	1
Pulmonary Edema	1
Postoperative Irregularities of the Heart Rhythm	21
Acute Delirium	1
Mental Depression	1

*This has also been designated "Postcardiotomy Syndrome"

INCIDENCE OF ASCHOFF BODIES AND ITS RELATIONSHIP TO THE AGE OF PATIENTS

The incidence of Aschoff bodies and its relationship to the age of patients was analyzed in 84 patients Aschoff bodies were found in the atria of 18 patients One patient under 20 years of age had Aschoff bodies

Twelve patients, whose ages ranged from 21 to 30 years, had mitral valvulotomies The atria of four of these (33.5 per cent) had positive Aschoff bodies, there were 36 patients from 31 to 40 years with eight (22 per cent) Aschoff positive, 31 patients from 41 to 50 years with four (13 per cent) positive There appears to be a greater incidence of Aschoff bodies in the younger age group This relationship is not exact because five patients over 50 years of age were operated upon, and two of them had Aschoff bodies in the auricular appendages

ASCHOFF BODIES IN RELATION TO THROMBI IN THE LEFT AURICLE AT OPERATION

Eighty-two patients were analyzed with respect to the relationship between Aschoff bodies in the left atria and the finding of thrombi in the auricle at the time of operation Sixty-eight patients (83 per cent) did not exhibit thrombi at operation In fifteen of these the atria had Aschoff bodies, an incidence of 22 per cent Fourteen patients (17 per cent) exhibited thrombi at operation, three (21 per cent) of whom were Aschoff positive

The incidence of Aschoff bodies was not greater in those with thrombi than in those without this complication

Eighteen (22 per cent) of 82 patients exhibited Aschoff bodies and 64 (78 per cent) did not have this manifestation Thrombi were present in three of the 18 patients exhibiting Aschoff bodies, an incidence of 17 per cent Thromi were present in the atria of 11 of 64 patients without Aschoff bodies, an incidence again of 17 per cent It appears that the presence of Aschoff bodies does not increase the incidence of mural thrombi

ASCHOFF BODIES AND CARDIAC RHYTHM

The relationship of Aschoff bodies to the cardiac rhythm was analyzed in 84 patients Eighteen (21 per cent) of these patients

had Aschoff bodies in their atria Five (28 per cent) of these 18 exhibited auricular fibrillation and 13 (72 per cent) normal sinus rhythm

Sixty-six patients (79 per cent) did not have Aschoff bodies in their left atria Forty-one (62 per cent) exhibited auricular fibrillation and 25 (38 per cent) normal rhythm

It appears that Aschoff bodies occurred almost twice as frequently in the left atria of patients exhibiting normal rhythm as in those with auricular fibrillation

From another point of view in 46 patients in whom auricular fibrillation was present the atria in only five (11 per cent) had Aschoff bodies On the other hand there were 38 patients in whom normal rhythm was present and in the atria of 13 of these (34 per cent) Aschoff bodies were found

CHEST PAIN AND ACUTE RHEUMATIC FEVER AFTER MITRAL VALVULOTOMY

Many patients in the postoperative period complained of pain in the chest sometimes associated with respiration coming on at intervals of several weeks to several months after operation either in one episode or in repeated episodes This has come to be known in the literature as the Postvalvulotomy Syndrome In these patients efforts were made to rule out pulmonary infarction as a cause of the pain and we have separated such patients out from the others now under discussion

Sixteen of the eighty-five patients in this analysis exhibited certain complaints which we have grouped in four categories

1) Nine patients had left pleuritic chest pain fever elevation of white blood cell count three of these had effusion in the left pleural cavity One patient had enlargement of the cardiac shadow in the x ray of the chest which was interpreted as due to pericardial effusion which was attributed to active rheumatic carditis.

2) Three patients suffered severe left pleuritic chest pain without additional manifestations

3) Three patients had left pleuritic chest pain arthralgia fever and elevation of white blood cell count Two of these had left pleural effusion also One patient was thought to have active rheumatic fever

4) Two patients had left pleuritic chest pain and fever, without elevation of white blood cell count. One of these had enlargement of the cardiac shadow in the x-ray of the chest which was thought to be due to pericardial effusion and was attributed to possible activity of rheumatic infection.

Sixteen (19 per cent) of 85 patients suffered pleuritic pain and various combinations of other manifestations. This number would be increased by one if all 100 patients were included.

Certain patients had a single episode of chest pain of varying duration, while others had recurrent attacks.

Treatment of this group of symptoms was symptomatic: aspirin, sedatives, codeine as required for respiratory distress. For certain patients with severe pain which was refractory to treatment, intercostal nerve block was done. Cortisone was not used in the first 100 patients in the treatment of this complication.

We have not come to any definite opinion about the cause of this group of symptoms and signs: whether due to activity of rheumatic fever and rheumatic carditis, or acute pericarditis, or primarily pleural involvement. We have not observed that this sequence of events occurred any more frequently in patients in whom the auricular appendage removed at operation showed Aschoff bodies than in those free of them. It will be pointed out later (p. 125) that it may be related to cardiotomy.

RESULTS OF MITRAL VALVULOTOMY IN PATIENTS OVER 55 YEARS OF AGE

Two patients were 55 years or over when subjected to mitral valvulotomy. One was markedly, the other moderately improved.

One patient, a 55 year old woman (Case No. 17, K.M., N.Y. Hospital Hist. No. 545000) was accepted for operation because of increasing exertional dyspnea, orthopnea, and easy fatigability. Auricular fibrillation was present. The murmurs of mitral stenosis and insufficiency were heard. The lungs were clear. The liver and spleen were both palpable. Medication consisted of a low salt diet, digitalis and mercurials. At operation the mitral valve was calcified and its area increased from 1.3 to 3 sq. cm. by valvulotomy. At follow-up one year and nine months after operation she was thought to have been markedly improved. Her

TABLE 6

VALVULOTOMY PERFORMED DURING PREGNANCY IN FIRST 100 PATIENTS

Case No. N.Y. Hospital History No.	Age	Month of Pregnancy	Previous Pregnancies	Reason for Operation	Murmur	Operative Split	Complications of Operation	Delivery	Complications of Delivery	Condition of Infant	Month Follow-up	Status at Follow-up	Comments
Case No. 52 C. D. 614549	25	5	2	Progressive dyspnea; paroxysmal nocturnal dyspnea	M S M I	Good	None	Normal full term delivery	None	Good	14	2+ improvement	
Case No 63 K R 5178	41	4½	4	Some dyspnea, hemoptysis	M S M I	Good	Troublesome bleeding at base of appendage	Normal full term delivery	Transient friction rub heard at left base on 2nd post partum day	Good	9½	1+ improvement	3 weeks post partum. Auricular fibrillation. Decompensation. ?Pulmonary embolus. Digitalis stopped by error
Case No 86 L. S. 664979	24	5	0	Paroxysmal nocturnal dyspnea	M S	Good	None	Normal full term delivery	None	G o d	6	1+ improvement	
Case No. 90 M. C. 303481	32	3	1	Probable pulmonary edema	M S	Good	Small piece of calcium released into circulation	Spontaneous premature delivery (6th mo.)	None	Died	6	unimproved	Pulmonary edema recurred after operation. Psychosis. No more pulmonary edema after delivery. Gradual recovery from psychosis.
Case No. 95 S. G 667460	18	5	0	Paroxysmal nocturnal dyspnea	M S. M. I.	Good	None	Normal full term delivery	None	Good	6	1+ improvement	

mitral valvulotomy is of benefit to properly selected pregnant women who have mitral stenosis, and in whom symptoms are occurring which impress the clinicians that there are hazards to the continuance of pregnancy in this cardiac setting, namely of a stenosed mitral valve

PATIENTS WHO HAVE HAD SECOND OPERATIONS FOR MITRAL STENOSIS

Two patients had two mitral valvulotomies Case No 9 (F L, N Y Hospital Hist No 614897), a man, 35 years of age, was accepted for operation on the first occasion because of severe exertional dyspnea, orthopnea, hemoptysis, and an episode of acute pulmonary edema Clinically the patient was thought to have pure mitral stenosis Auricular fibrillation was present The blood pressure was 130/70 Cyanosis, pulmonary râles and hepatomegaly present on admission responded to medical therapy. The electrocardiogram showed evidence of right ventricular hypertrophy The hemodynamic data obtained at cardiac catheterization were consistent with mitral stenosis (11/23/51, Table 7) The pulmonary "capillary" pressure tracing showed evidence of mitral insufficiency and the right atrial pressure curve was typical of mild tricuspid insufficiency

At operation the valve orifice was under 1 0 sq cm in size The orifice was increased in size by digitally separating the antero lateral commissure to well over 2 sq cm However, the mild mitral insufficiency present at the beginning of the procedure was estimated to be four times as great after the split Because of the increase in the mitral insufficiency, the postero-medial commissure was not fractured The micriscopic examination of the left atrial appendage did not give evidence of acute rheumatic carditis

The patient was markedly benefited by operation There was also improvement in the postoperative catheterization data (1/11/52, Table 7) Evidence of mitral insufficiency and of tricuspid insufficiency was again seen in the curves

The clinical improvement was maintained for about two years Coincident with numerous upper respiratory infections during the winter of 1953-1954 the patient became worse, but his status

TABLE 7

PRE AND POSTOPERATIVE CATHETERIZATION DATA OF CASE NO 9 AND CASE NO 31 EACH HAVING HAD TWO OPERATIONS FOR MITRAL STENOSIS

Patient Cat No.	History No.	Date of Observation	Date of Mitral Valvulotomy	O_2 Consumption		Cardiac Output		Cardiac Index		Pulmonary Capillary Pressure		Pulmonary Artery Pressure		Right Ventricular Pressure		Right Atrium Pressure		Pulmonary Vascular Resistance		Mitral Valve Area
				cc/min./M²		L/min.		L/min./M²		mm. Hg		mm. Hg		mm. Hg		mm. Hg		dynes/sec. cm		cm
				Rest	Exer	Rest	Exer	Rest	Exer	Rest	Exer	Rest	Exer	Rest	Exer	Rest	Exer	Rest	Exer	Rest
L. No. 9	614897	11/23/51		146	317	3 70	4 30	2.39	2 71	28	57	50/24	115/61	48/3		3		216	514	0 93
			12/1/51 (First)																	
		1/11/52		145	304	3 53	4 90	2.26	3 14	12	34	44/17	96/47	42/7		6	—	317	424	1 42
		11/1/54		127	214	3.50	3 64	2.15	2.23	25	47	46/24	105/50	46/6		5		274	483	0 7
			12/3/54 (Second)																	
H. No. 31	629970	7/16/52		135	433	5 59	10 44	3 80	7 10	17	31	27/17	45/30	36/4		4		86	38	2.5
			7/18/52 (First)																	
		1/19/54		159	242	5 69	5 47	3 90	3 75	25	38	39/21	54/33	38/4		0	2	42	73	1 68
			7/12/54 (Second)																	

We wish to thank Dr. Daniel S. Lukas for these data.

did not regress to as severe a state as preoperatively. Two years and eleven months after the first operation, however, he was readmitted to the hospital in acute pulmonary edema. This was treated successfully. The patient was recatheterized two weeks afterwards (11/1/54, Table 7). The data showed that the mitral valve orifice was now smaller than that which had been calculated before the first operation. Pulmonary "capillary" and pulmonary artery pressures had risen almost to their preoperative levels. Ability to increase output with exercise had decreased as indicated by the ratio of output to oxygen consumption. Evidence of mitral insufficiency was again recorded.

Clinically the patient was now in approximately the same status as before mitral valvulotomy. The murmurs of mitral stenosis, mitral insufficiency and tricuspid insufficiency were heard. He was accepted for a second exploration of the mitral valve. During the second operation, three years after the first, Dr. Frank Glenn encountered and aspirated what was considered to be an organized clot in the left auricle. There were no other clots in the left auricle and slight mitral insufficiency was thought to be present. The aperture in the mitral valve was more laterally placed than before the first operation and the surgeon thought that it was in the region of the previous commissurotomy. It would barely admit the tip of the finger. The remainder of the valve was very thick, rigid and immobile. Numerous attempts were necessary to obtain a satisfactory split medially reaching over to the interauricular septum. The degree of mitral regurgitation was increased. The surgeon was gratified, however, that the aperture was increased in size. The valve was calcified and a few pieces of calcium may have been lost into the circulation during the fracture. The patient withstood the operation well and had an uncomplicated postoperative course of two weeks duration. At discharge his exercise tolerance was greater than before the operation.

Immediately upon arrival at home, the patient complained of not feeling well. He experienced chest pain and returned to the hospital. He died in the Emergency Room of The New York Hospital in shock. (See Table 28.)

At autopsy (Figures 2 3 4 5) the endocardium of the left atrium was greatly thickened and hyalinized There was a thrombus in the base of the left auricular appendage A fresh thrombus was found in the left auricle which had not been observed at the time of operation The mitral valve was very distorted The surgical split was found postero-medially extending to the auricular wall (Figure 4) Microscopically small areas of focal necrosis of muscle fibers were observed in the left auricle There was active connective tissue proliferation in the mitral valve cusps

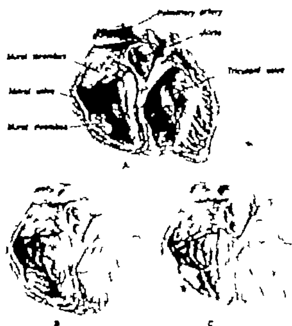


Figure 2. In this figure as well as in Figures 3 4 and 5 are artist's drawing (Figure 2) or photographs of the heart (Figures 3 4 and 5) Case No 9 (F L, N Y Hospital History No 614897) The protocol including autopsy findings are found in Part I Section III, p 50 In this drawing the left atrium is shown from above with mitral stenosis before first operation Figure 2A and Figure 2B show the mitral valve after anterolateral commissurotomy and in Figure 3C the extent of stenosis of the mitral valve as it was found three years later at the second operation It is to be observed that the anterolateral commissure has remained open and that the stenosis is present in the area of the postero-medial commissure See also Figures 3 4 and 5

Figures 2, 3 4 and 5 are reproduced from *Recurrent Mitral Stenosis — A Case Report* Glenn, Frank, M D., and Dineen Peter M.D *Ann Surg., 143* 405 1956

and an organized layer of platelets on its surface The over all character of the valvulitis appeared older than the two weeks postoperative period The final anatomical diagnosis was active rheumatic valvulitis and probable active rheumatic myocarditis The resealing of the valve that had occurred between the two operations was considered due to this process There was moderately advanced atherosclerosis, but there was no evidence of a coronary occlusion having occurred There was also no evidence of cerebral thrombo-embolism The immediate cause of death was not found

The second patient, a woman 23 years of age (Case No 31, J H., N Y Hospital Hist No 629970), was admitted because of increasing shortness of breath and fatigue The patient had had a normal full-term delivery five years before admission A therapeutic abortion had been performed because the patient had a



Figure 3 In this figure* is reproduced a photograph of the heart from above (Case No 9) showing the left atrium on the left with two mural thrombi

* Figures 2, 3, 4 and 5 are reproduced from *Recurrent Mitral Stenosis — A Case Report*, Glenn, Frank, M D, and Dineen, Peter, M D *Ann Surg*, *143*: 105, 1956

bad heart She became pregnant again however shortly afterward and in the fifth month developed bronchopneumonia Following this latter episode her clinical course had deteriorated until at the time of admission she could walk only one to two blocks experienced two pillow orthopnea and complained of increasing fatigability

On examination the classic murmur of mitral stenosis was



Figure 4 In this figure* is reproduced a photograph of the mitral valve from the atrial side (Case No 9) It is apparent that the anterolateral commissure is widely patent as is the postero-medial commissure which was split during the second valvulotomy The top of the photograph is anterior

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Figures 2, 3 4 and 5 are reproduced from *Recurrent Mitral Stenosis — A Case Report* Glenn, Frank M.D., and Dineen Peter M D *Ann Surg 143* 405 1956

heard The results of cardiac catheterization (July 16, 1952, Table 7) were compatible with mild to moderate mitral stenosis with excellent right ventricular function

The patient also exhibited changes in the skin which were consistent with the diagnosis of scleroderma It was the opinion that visceral involvement of this disease was not responsible for the hemodynamic changes recorded in Table 7

She was accepted for mitral valvulotomy At operation the mitral valve was estimated at 1 sq cm Medially there was a small amount of calcium imbedded within the valve There was definite regurgitation A slight split was obtained laterally, a split medially required numerous attempts Regurgitation was increased by the valvulotomy The surgeon noted that the anterior valve was somewhat shorter than usual and did not bulge well, whereas the posterior had more mobility than had usually been found with the degree of stenosis encountered in this patient There



Figure 5 In this figure* is reproduced a photograph of the mitral valve and the tricuspid valve from the ventricular side (Case No 9) The shortened and thickened chordae tendineae of the mitral valve on the right side of the photograph compared with the tricuspid valve on the left

* Figures 2, 3, 4 and 5 are reproduced from *Recurrent Mitral Stenosis — A Case Report* Glenn Frank M D and Dineen, Peter, M D *Ann Surg*, *143* 105, 1956

was fixation of the valve medially The biopsy of the auricular appendage showed acute rheumatic endocarditis

The patient had a postoperative course without complications and she was thought to be improved for the first six to twelve months Thereafter symptoms recurred and her clinical course deteriorated.

The patient was recatheterized 18 months after the first opera tion (Table 7 1/19/54) The deterioration in the hemodynamic pattern was considered as best ascribed to re sealing of the mitral valve.

She was accepted for a second exploration of the mitral valve two years after the first one On entering the auricle through the obliterated auricular appendage Dr Frank Glenn encountered a regurgitant stream of blood The valve opening measured about 1 0 sq cm and was mainly lateral in location The medial portion of the valve was scarred but a satisfactory split was obtained in this direction The resulting aperture was approx imately 3 0 sq cm and regurgitation was not increased The valve pathology was considered due to refusion and further scarring since the first operation

Postoperatively the patient did well An examination performed three years and four months after the second operation found the patient doing well She was improved by the second mitral valvulotomy

Section IV

DISCUSSION

The surgical treatment of mitral stenosis, namely enlarging the narrowed orifice through which blood flows from the left auricle into the ventricle, is established on a sound rationale When the stenosis has been gradual and slow in development over a prolonged period, associated conditions are very likely to have developed that may be expected to have a bearing on what may be accomplished by operation One or more of the other heart valves may be impaired, the myocardium may have been damaged because of rheumatic fever with consequent inability to compensate for the increased load placed upon it, or as seen in the older age group, there may be superimposed atherosclerosis of the coronary circulation Gradually increasing and prolonged pulmonary hypertension is likely to be associated with sclerosis of the pulmonary vessels The deposition of calcium in the valve area, auricular fibrillation, thrombus formation within the left auricle are manifestations of changes that have been quite some time in the making and while each in itself may not appear to effect the outcome of the operation, altogether, they provide a basis for altering the prognosis

As is true for many conditions for which surgery is undertaken, mitral stenosis sufficiently rapid in onset to cause acute symptoms yet not of long enough duration to have caused or become associated with irreversible changes, can be corrected with minimal risk and maximal efficiency This might suggest that the diagnosis of mitral stenosis without symptoms of decompensation is an indication foi operation This is not held to be true by us because we have no way of knowing when the process will produce a critical reduction of blood flow Furthermore operation is directed only at overcoming the stenosis and may have no effect upon the rheumatic process which may and probably does quite frequently

persist to produce further distortion of the valve and its supporting ring

The opening of the stenosed valve if that be the only lesion will usually be followed by dramatic and progressive improvement If on the other hand the aortic or tricuspid valves are involved or the patient has sustained emboli or has had increasing difficulties from pulmonary hypertension the patient's condition is one of poor prognosis if nothing is done The risk of operation is increased and the results not so dramatic Nevertheless the comparative relief of symptoms and prolongation of life may be almost equal Poor risk patients should under these circumstances, offer a greater field for extending the surgical treatment of mitral stenosis rather than those who are without symptoms

Those who embark upon this work need the personnel facilities of a general hospital of some size It is not a task to be undertaken single handed by a surgical group able as they may be The cardiologist and the internist by tradition training, and experience are better equipped in particular to recognize the conditions that are of great importance from a prognostic viewpoint Furthermore their appraisal of previous therapy and trial medical management during evaluation for mitral valvulotomy are significant factors in predicting results The supportive measures that the heart requires following the burden of operation the surgeon must learn from the cardiologist. In turn it may be said also that the cardiologist may learn much from the surgeon's findings at the operation Murmurs are an aid in diagnosis but like other data require interpretation in the light of the entire clinical picture

Any group beginning such a cooperative venture will profit from assuming an attitude of learning from each other as well as individually The sources of information are numerous and increasing The cardio-physiologist and the angio-cardiographer as well as the radiologist are much in the foreground of this development The anesthetist and the surgeon are brought into closer interdependence in cardiovascular surgery than in almost any other of their common endeavors The roles of each of these individuals are essential in the diagnosis selection and manage

ment of the patients who are to be treated surgically Collectively they will have a record of successful accomplishment, individually this is not so likely

In this small series impressions and trends are apparent and rigid conclusions are not justified In the diagnosis of valvular lesions it appears that mitral insufficiency is difficult to evaluate in the presence of stenosis Multiple valve involvement is an indication for extra care in evaluation Pulmonary symptoms and embolic phenomena are indications for consideration of urgent surgery Older age patients with prolonged histories of cardiac disease should be carefully observed in the hospital for a period sufficient to ascertain their over-all physiological capacities Optimal water and electrolyte balances and their strict maintenance before, during and immediately after operation may avert overloading the circulation

In the actual performance of the operation it seems evident that separation of both commissures should be complete Although the valve orifice may be enlarged enough to provide relief by separation of one fused commissure the immediate results are better if both are separated The follow-up studies indicate that recurrence is more likely to occur when one side only is separated One of the more difficult problems encountered by the surgeon has been the shortened valve leaflet with some degree of but not marked insufficiency Freeing the chordae tendineae after separation of the commissures sometimes results in a decrease in the insufficiency and sometimes an increase Direct vision would enable one to better decide what is best to do in this situation With increasing experience it appears that the fixed-shortened valve cusp is seldom successfully mobilized

Section V

SUMMARY

This is a report of the first 100 patients to be selected for mitral valvulotomy by the cardiovascular conference group at The New York Hospital — Cornell Medical Center The criteria employed in evaluating patients for operation are presented The preoperative preparation anesthesia surgical approach and immediate post operative management are briefly described There were three deaths among the patients who had mitral valvulotomies and relevant information is included in their protocols Operation was not accomplished upon the mitral valve in four patients who were explored One of the patients of these four in this latter category died in the immediate postoperative period One patient was lost to follow up and two patients could not be adequately evaluated Symptoms that developed during pregnancy led to operation in five patients These patients are considered as a separate group Information upon 85 patients who have been carefully followed has been subjected to critical review in an effort to determine the hazards and benefits associated with mitral valvulotomy

The results may be summarized

1 Sixty-one of the 85 patients (72 per cent) were considered to be improved as a result of mitral valvulotomy eighteen (21 per cent) were unchanged and six (7 per cent) were worse The patients were classified according to the New York Heart Association as follows Class I = 0 Class II = 5 Class III = 67 Class IV = 13

2 Fifty two of 69 women (76 per cent) were improved by mitral valvulotomy but only nine (56 9 per cent) of 16 men were improved

3 Forty-one patients exhibited normal sinus rhythm and 44 auricular fibrillation at the time of operation Seventy five per cent of the former and 69 per cent of the latter were improved

4 Patients diagnosed as having only mitral stenosis experienced the most improvement, minimal involvement of other valves did not seem to make a great deal of difference However, patients in whom an associated mitral insufficiency of moderate or severe degree was recognized before operation were not so frequently improved

5 Seven of 11 patients exhibiting murmurs of aortic insufficiency both before and after mitral valvulotomy were improved

6 Seventy-three of 85 patients had mitral orifice areas estimated to be less than 1 5 sq cm by the surgeon Fifty-five (75 per cent) of these were improved

7 The surgeon's evaluation of the adequacy of increase in the mitral orifice by the split is of importance in prognosis Accordingly, sixty-five patients were recorded as having satis factory enlargements of the orifice, of these 51 (78 per cent) were improved

8 Fifteen patients had marked and 46 slight to moderate calcification of the mitral valve Calcification of some degree was present in the mitral valves in 75 per cent of the patients The incidence was much higher in men, namely 93 per cent, than in women While the improvement rate was 60 per cent in those with marked calcification, there was no difference as to the result when calcification was moderate or slight but was higher than in those with marked calcification

9 Almost 50 per cent of the patients had some degree of mitral insufficiency detected by regurgitant streams at the time of operation It was induced in three patients when the valves were split The greater the insufficiency, the less the chance of the patient being improved

10 Two of 56 patients exhibiting auricular fibrillation before operation reverted to normal rhythm afterward Twenty of 14 patients in whom normal rhythm prevailed before operation developed auricular fibrillation in the postoperative period In all but six of these normal rhythm had been restored at the time of discharge from the hospital

11 Only two of 22 patients who had had pulmonary infarctions before valvulotomy suffered recurrences in the period of observation following operation

12 Eighteen patients had suffered one or more arterial emboli preoperatively After operation only one of these has sustained an arterial embolus

13 Embolic phenomena are diminished when the stenosed mitral valve is opened adequately There were eight patients who had thrombus material in the left auricle who had no antecedent emboli nor did they have any after the operation

14 Sixteen (20 per cent) of 85 patients suffered chest pain and associated clinical findings that led to the diagnosis of postvalvulotomy syndrome at intervals ranging from a few weeks to several months after operation

15 Five patients had mitral valvulotomies between the fourteenth and twenty-third week of pregnancy All went on to term except one who had a spontaneous abortion in the sixth month in the last mentioned case the infant died a few hours after birth

PART TWO

MITRAL VALVULOTOMY IN THE SECOND AND THIRD HUNDRED PATIENTS IN THE YEARS 1954 1955 AND TO APRIL 1956

With the assistance of

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The New York Hospital – Cornell University Medical Center

Section I

INTRODUCTION

In Part One our experience with one hundred patients selected for operation for mitral stenosis was reviewed It included a description of the approach employed and the criteria used A brief summary of the preoperative preparation, the surgical procedure, and the postoperative course was given Most of the report was devoted to an analysis of the results that it was felt were directly related to the surgical operation These were compared with the preoperative clinical findings as well as those described by the surgeon The objectives were to determine insofar as possible the accuracy of the diagnostic procedures and preoperative evaluation in the selection of suitable patients for operation, to correlate what the surgeon thought he accomplished with the patient's course postoperatively, and to evaluate clinically the results of mitral valvulotomy The report reflected a cautious approach of a group of physicians to problems that they were only partly familiar with Each problem had many facets, not all were considered, rather only the more important and most frequently encountered

The over-all results were encouraging, improvement being recorded as 72 per cent for 85 patients who had the operation completed as planned The morbidity of complications and the mortality rate were low, suggesting that perhaps the selection of cases had been to restrictive because of cautiousness It was also evident that hard and fast criteria would deprive many patients of an opportunity for whatever improvement operation might provide

There is now presented a comparable report on the second and third hundred patients selected for operation by the same group of physicians As in the first series, the preoperative evaluation was conducted by Harold J Stewart, M D and his staff and

the mitral valvulotomies were performed by Frank Glenn M D and his staff These 200 patients came to operation between January 1954 and April 1956 As experience has been accumu lated a greater proportion of seriously ill patients have been selected also there have been more in whom the likelihood of benefit was questionable as for example those individuals who had mitral insufficiency the extent of which could not be accurate ly determined Some of these have been greatly benefited and others with the similiar findings preoperatively have not been helped Patients with a very poor prognosis on medical manage ment have been operated upon in the hope that something could be accomplished with a valve that had for too long placed a burden upon the heart. For the most part these have been disappointing On the other hand age alone (over 50 years) has been demonstrated not to be a contraindication to operation even though younger patients are more frequently benefited

In the course of repeatedly examining patients who have been operated upon for mitral stenosis there has been evidence that suggests that in some patients the rheumatic process that produced the disease of the valve is no longer active These patients appear to improve for sometime after operation and sustain it well thereafter The opposite trend has been noted in those in whom the rheumatic process is thought to persist or recur In this group there has been reappearance of symptoms after a period of im provement progressing so that patients attained the preoperative status or were worse than before operation Only a few of these have been operated upon a second time but those patients who have had second operations have been described by the surgeon as having additional and marked changes of the entire valve and its ring with only minimal evidence of re-sealing of the split or operative separation of the commissure Continued re examination and evaluation of these patients during life and detailed studies of the hearts at postmortem should contribute to a better understanding of the possible role of the present indirect surgical enlargement of the stenosed mitral valve

The same format has been used in this analysis as in the first 100 patients so that the results could be compared

Section II

CLINICAL MATERIAL

PATIENTS SUITABLE FOR THE ANALYSIS

This report presents the results of the second and third hundred patients selected for mitral valvulotomy at The New York Hospital-Cornell Medical Center One hundred and seventy patients who had mitral commissurotomy could be analyzed for improvement Twelve of these patients were pregnant The remaining 30 patients (of the 200) who are not included in this analysis fall into the following groups

Exploratory thoracotomy or cardiotomy without operation on the mitral valve	14	
Deaths at operation or within the first postoperative month	12	(3 of these patients also had only an exploratory thoracotomy)
Left auricular myxoma giving rise to mitral stenosis found at operation	1	
Follow up less than 3 months	3	
Inadequate follow up	3	

The time of follow up ranged from 3 to 37 months, with an average of 16 months

PREOPERATIVE DIAGNOSIS OF VALVULAR INVOLVEMENT*

Fifty-two patients had pure mitral stenosis, 3 mitral stenosis and tricuspid stenosis (Table 8) Fifty-one patients were diagnosed preoperatively as having mitral stenosis and insufficiency Nine had mitral stenosis and aortic insufficiency, seven had mitral

* The preoperative clinical diagnoses were the responsibility of Harold J Stewart M D

stenosis mitral insufficiency and aortic insufficiency The combination of mitral stenosis mitral insufficiency aortic stenosis and aortic insufficiency was not found in this series One patient had mitral stenosis mitral insufficiency pulmonic insufficiency and four had mitral stenosis and aortic stenosis Forty three patients had tricuspid insufficiency all with mitral stenosis as the predominant lesion Of these 43 cases nine had mitral stenosis and tricuspid insufficiency alone and 17 had mitral stenosis mitral insufficiency and tricuspid insufficiency The remaining 17 cases with tricuspid insufficiency had various combinations of valvular lesions (Table 8) A total of 87 cases had the clinical diagnosis of mitral insufficiency always with mitral stenosis and at times with other valvular lesions At operation the surgeon found marked

TABLE 8

PREOPERATIVE VALVULAR DIAGNOSES IN 170 OF THE SECOND AND THIRD HUNDRED PATIENTS

Valve	*Number of Patients*
M S only	52
M S. predominating T S	3
M S predominating M I	51
M S predominating A I.	9
M S predominating M I A. I	7
M S. predominating M I A S A I	0
M S predominating A S	4
M S. predominating M I P I	1
Patients with Tricuspid Insufficiency	
(associated with other valvular lesions—43 pts.)	
M S predominating M I T I	17
M S predominating T I	9
M S predominating A I T I	2
M S predominating M I A I T I	3
M S predominating M I A. S A I T I	2
M S predominating A S T I	1
M S predominating M I A S T I	1
M S predominating M I T S T I	3
M S predominating T S T I	3
M S predominating M I P I T S T I	1
M S predominating P I T I	1
Total	170

In all instances mitral stenosis was thought to be the prpedominant lesion, with moderate to slight other valve lesions as indicated in the table

mitral insufficiency in 14 patients In some of these cases, it was recognized preoperatively that the degree of mitral insufficiency might be considerable, but the operation was performed to treat the mitral stenosis in an attempt to alter the downhill course of the patient

AGE OF PATIENTS

The youngest patient was 19 years old and the oldest was 63 (Figure 6) Most of the patients were in middle life. Almost the same number were in the third and fourth decades About

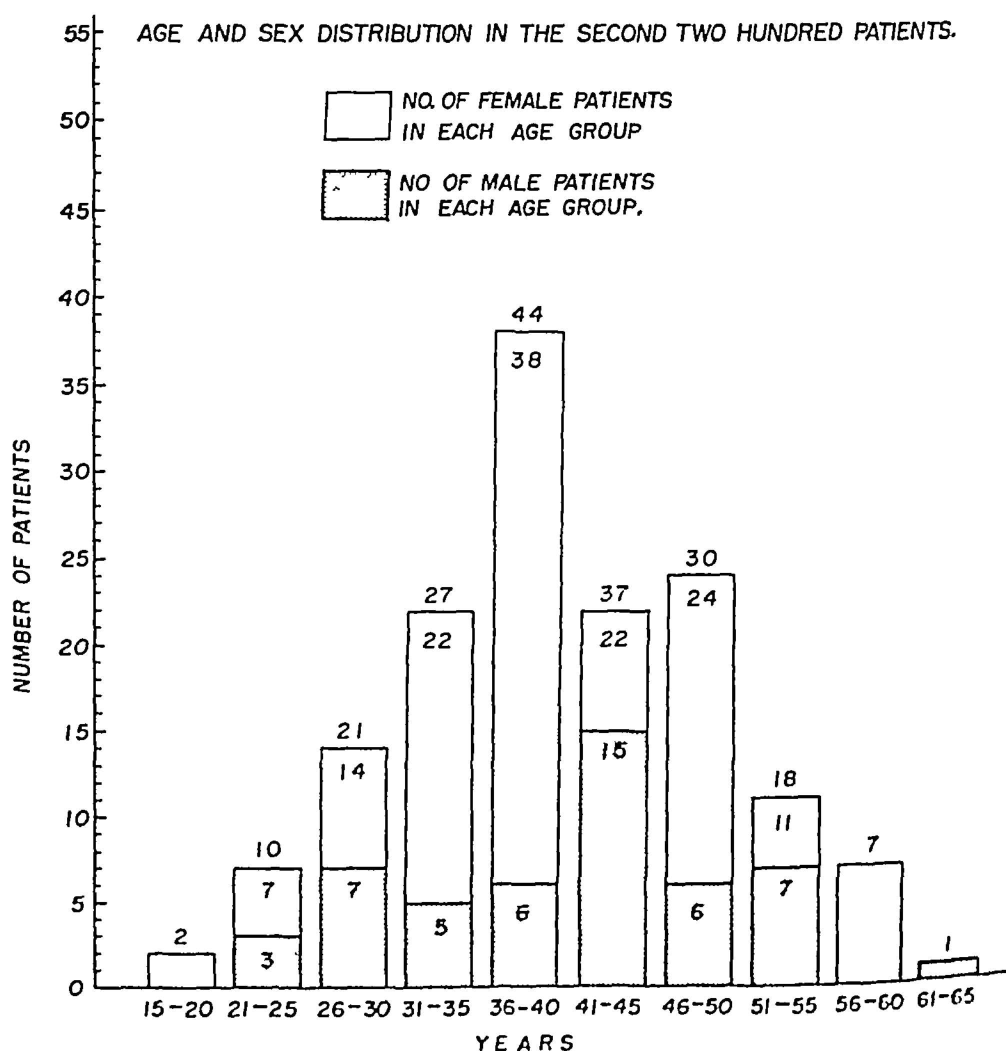


Figure 6 In this figure are shown the age and sex distributions of the second and third hundred patients on whom mitral valvulotomies were performed

three quarters of the patients were female

The age and sex incidence in the second 200 patients is similar to that in the first 100 patients (Figure 6) Three patients in whom follow ups could not be obtained are not included

MORTALITY

Twelve patients died within the first postoperative month Of these two died on the table and two within the first twenty-four hours after operation Autopsy was performed on all but three of the twelve patients (Table 9)

Case No 108 (R.P N Y Hospital History No 668782) a 39 year old man complained of severe exertional dyspnea and frequent attacks of paroxysmal nocturnal dyspnea. Auricular fibrillation was present murmurs of mitral stenosis and tricuspid insufficiency and a loud murmur of mitral insufficiency were heard Chronic heart failure was present An electrocardiogram showed right ventricular hypertrophy An angiocardiogram showed generalized cardiac enlargement Cardiac catheterization yielded data consistent with the clinical diagnosis of mitral stenosis and insufficiency Therapy consisted of a low salt diet digitalis and mercurials The preoperative New York Heart Classification was IV E

At operation the left auricle could not be entered because of an intramural clot and calcification Postoperatively the patient remained in refractory heart failure and died on the sixteenth postoperative day

At autopsy the mitral valve measured 0 5 by 1 5 cm The left atrium was five times normal size Its wall was calcified The auricle contained an intramural clot. Both the right auricle and the right ventricle were three times normal size There was a pulmonary infarct in the right lower lobe Atherosclerosis of the coronary arteries was present

Case No 134 (P R N Y Hospital History No 686104) a 51 year old woman complained of progressive exertional dyspnea and orthopnea Auricular fibrillation was present The murmurs of mitral stenosis tricuspid insufficiency and a soft murmur of mitral insufficiency were heard Chronic heart failure was

TABLE 9

PATIENTS WHO DIED ON THE TABLE OR WITHIN 30 POSTOPERATIVE DAYS

Case No N Y Hospital History No	Age Sex	Preoperative Classification	Reason for Operation	Preoperative Valvular Diagnoses	Valve at Operation	Complications at Operation	Time of Death After Operation	Postoperative Course	Reason for Death	Autopsy
Case No 103 R P 668782	39 male	IVE	Completely incapacitated by heart failure	M S M I T I	Auricle not entered	Calcified left auricular wall, intramural clot	16 days	Intractable heart failure, electro lyte imbalance, cyanosis terminally	Heart failure and pulmonary embolus	Mitral valve 1 5 x 0 5 cm, left atrial calcification and clot, large right atrium and ventricle, pulmonary infarct, atherosclerosis of coronary arteries, heart weight 1100 gms Thrombus in right auricle
Case No 134 P R. 686104	51 female	IVD	Exertional limitation	M S slight M I T I	1 cm² in area Successful valvulotomy 3 cm² after operation Some calcification	None	21 days	Hypotension 12 hours post operatively, low serum sodium After 8th day refractory heart failure Auricular paroxysmal tachycardia.	Heart failure	Splits in mitral valve medially 8 mm, laterally 3 cm Mitral valve leaflets thickened, chordae shortened thickened and fused Organic lesion of tricuspid valve causing T I, large right ventricle Heart weight 625 gms Recent pulmonary infarct in left lower lobe
Case No. 138 S K. 685516	44 male	IVD	Dyspnea at rest	M S M I A S, A I T I	1 cm² in area successful valvulotomy 3 cm² afterwards Marked calcification	None	3 days	Hypotension on second postoperative day	Died in shock	Heavily calcified mitral valve Admitted one finger Fractured at 4 points 5 mm maximum depth Orifice measured 2 x 2 cm 5 mm aortic valve orifice Tricuspid valve normal

TABLE 9—(continued)

PATIENTS WHO DIED ON THE TABLE OR WITHIN 30 POSTOPERATIVE DAYS

Case No. N. Y. Hospital History No.	Age Sex	Preoperative Classification	Reason for Operation	Pre-operative Valvular Diagnosis	Valve at Operation	Complications at Operation	Time of Death After Operation	Postoperative Course	Reason for Death	Autopsy
Case No. 138 S. K. 685516 Cont'd										Right ventricle and both atria dilated. Two small areas of fibrosis in left ventricle with patent coronary arteries to that area. Two old renal infarcts.
Case No. 142 C. F. 528008	39 female	III C	Severe exertional dyspnea and fatigue. Recurrent systemic and pulmonary emboli.	M. S. M. I. A. I.	Between 0.5 and 1.0 cm² marked calcification	Cardiac arrest and hypotension after evacuation of left auricular clot.	On table		Cardiac arrest on table	1.5 × 3 cm mitral valve. Other valves normal except for slight thickening of leaflets and chordae of tricuspid valve. All thrombi had been evacuated. Only mild coronary sclerosis. Heart weight: 350 gms. Old infarct of internal capsule and basal ganglia. Old infarct of spleen.
Case No. 159 F. F. 696179	43 female	III C	Progressive dyspnea	M. S.	1 cm before; 2 cm² after valvulotomy; some calcification	Tear of left auricular wall. Unsuccessful attempt to remove left auricular clot.	3 hrs.	Both legs cold, terminal dyspnea and cyanosis, saddle and probable pulmonary emboli.	Arterial and probable pulmonary emboli.	Not done.

TABLE 9—(continued)

PATIENTS WHO DIED ON THE TABLE OR WITHIN 30 POSTOPERATIVE DAYS

Case No N Y Hospital History No	*Age Sex*	*Preoperative Classification*	*Reason for Operation*	*Preoperative Valvular Diagnoses*	*Valve at Operation*	*Complications at Operation*	*Time of Death After Operation*	*Postoperative Course*	*Reason for Death*	*Autopsy*
Case No 188 M Mc [illegible]	18 male	III C	Progressive dyspnea pulmonary edema hemoptysis	M S	1 cm² before, 3-4 cm² afterwards Some calcification	Cardiac standstill with split	On table		Possibly related to Boeck s sarcoid	Boeck s sarcoid in myocardium and lymph nodes Both auricles and ventricles large Minimal rheumatic changes in aortic and tricuspid valves Mitral valve leaflets thickened, fused mass of chordae Two surgical incisions in valve were 3 and 0 5 cm respectively in depth Heart weight 520 gms
Case No [illegible] F M [illegible]	[illegible] female	IV D	Completely incapacitated by heart failure	M S M I	Auricle not entered	Dense pericordial adhesions probably related to previous insufflation of talc powder	12 hrs	Various arrhythmias including paroxysmal ventricular tachycardia shock	Heart failure and inability to enter auricle to relieve mitral obstruction	Not Done

TABLE 9—(continued)

PATIENTS WHO DIED ON THE TABLE OR WITHIN 30 POSTOPERATIVE DAYS

Case No. N Y Hospital History No.	*Age Sex*	*Preoperative Classification*	*Reason for Operation*	*Preoperative Valvular Diagnoses*	*Valve at Operation*	*Complications at Operation*	*Time of Death After Operation*	*Postoperative Course*	*Reason for Death*	*Autopsy*
Case No. 224 J. S. 599744	20 female	IVD	Progressive dyspnea, pulmonary edema, hemoptysis	M. S. M. I. A. S. A. I. T. I.	No stenosis, marked regurgitation. No calcification	Mild pulmonary edema	10 days	Borderline pulmonary edema since operation. Heart failure intractable. Death in shock and pulmonary edema	Heart failure and recent pulmonary infarct	Dilated atria. Left ventricle 20 mm. thick and dilated. Right ventricle 5 mm. thick. Minor changes in tricuspid and aortic valves. Marked changes in mitral valve. One ruptured papillary muscle. Fibrinous exudate on heart. Microscopic fibrinoid degeneration and Aschoff bodies. Heart weight 450 gm. Pulmonary congestion and one recent infarct. Old renal infarct.
Case No. 231 A. S. 729677	49 female	III C	Progressive dyspnea, pulmonary edema	M. S. M. I. A. S.	1 cm² before 3 cm² afterwards, no calcification	B. P. fell while clot was being removed and during fracture.	3 days	Heparin started near end of operation and continued until death. Hypotension 6 hours post-operatively	Heart failure, shock; hemorrhages into various organs; bilateral renal infarcts	All chambers hypertrophied. Moderate dilation of atria and right ventricle. Evidence of mitral and aortic stenosis. Multiple hemorrhages into skin subcutaneous tissues of chest wall, pleural cavity, stomach, left lung. Pulmonary edema and passive congestion of viscera. Heart Weight, 580 gm. Massive

TABLE 9—(continued)

PATIENTS WHO DIED ON THE TABLE OR WITHIN 30 POSTOPERATIVE DAYS

Reason for Operation	Preoperative Valvular Diagnoses	Valve at Operation	Complications at Operation	Time of Death After Operation	Postoperative Course	Reason for Death	Autopsy
					No response to vigorous therapy		bilateral renal infarcts involving almost all cortex of each kidney
rogressive spnea, emoptysis	M S, interatrial septal defect, partial anomalous pulmonary venous drainage	2 cm² before, 3 cm² afterwards a round not fishmouth mitral valve no calcification	None	3 days	On second postoperative day, dyspnea and cyanosis Complete heart block Shock on 3rd postoperative day	Shock	1 Interatrial septal defect with another communication below it 2 Mitral valve commissures fused, leaflets thickened 3 Large pulmonary artery, right ventricle, right auricle 4 Absence of superior vena cava, right innominate enters left auricle along with right pulmonary vein, left innominate enters coronary sinus 5 Passive congestion of lungs with pulmonary edema Heart and lungs weighed 1700 gm No evidence of embolization
rogressive yspnea	M S M I T S T I	1 cm² before 3 cm² afterwards some calcification	None	2 days	B P fell on night of operation never returned to normal	Shock	Not done

TABLE 9—(continued)

PATIENTS WHO DIED ON THE TABLE OR WITHIN 30 POSTOPERATIVE DAYS

Case No. N Y Hospital History N	Age Sex	Preoperative Classification	Reason for Operation	Pre-operative Valvular Diagnoses	Valve at Operation	Complications at Operation	Time of Death After Operation	Postoperative Course	Reason for Death	Autopsy
Case No 300 J. M. 762318	43 male	III C	Progressive dyspnea, hemoptysis, probable cerebral emboli.	M. S T L	Less than 1 cm² before 2½ 3 cm² afterwards, marked calcification.	None	3 days	Uncomplicated Dicoumarol begun on first postoperative day	Occlusion of mitral valve by ball valve thrombus.	All 4 chambers dilated Right ventricle hypertrophied, mitral valve thickened, calcified nodular on surface chordae thickened, fibrotic, shortened, slight thickening of tricuspid and aortic valves. Mitral valve area 2 cm² after valvulotomy Recent and old renal infarcts, Recent splenic infarct 5 cm. laminated thrombus filled atrial appendage remnant. A recent thrombus 5 cm. in diameter attached to the other one occluding the mitral orifice. Heart weight: 520 gms.

present X-ray photograph of the chest showed left auricular and left ventricular enlargement and pulmonary congestion The electrocardiogram showed right ventricular hypertrophy Therapy consisted of a low salt diet, digitalis, and almost daily mercurials Preoperative New York Heart Classification was IV D

At operation the mitral valve was 1 0 sq cm in area, mitral insufficiency was not detected The surgeon estimated that a successful valvulotomy had been performed The blood pressure fell twelve hours postoperatively, but returned to normal levels with treatment However, after the eighth postoperative day the heart failure became refractory and the patient died on the twenty-first postoperative day

A flabby myocardium and an incompletely corrected mitral stenosis and tricuspid insufficiency were found at autopsy

Case No 138 (S K, N Y Hospital History No 668782), a 41 year old man, was admitted because of incapacitation by dyspnea and other evidences of congestive heart failure Auricular fibrillation was present The murmurs of mitral stenosis and insufficiency, aortic stenosis and insufficiency, and tricuspid insufficiency were heard Heart failure was present An x-ray photograph of the chest showed a left auricle and a right ventricle which were large and congested lung fields There was evidence of right ventricular hypertrophy in the electrocardiogram Therapy consisted of a low salt diet, digitalis, mercurials, and ammonium chloride Preoperative New York Heart Classification was IV D The patient was thought to be a poor operative risk

At operation the mitral valve was found to be 1 0 sq cm in area The surgeon thought that a successful valvulotomy had been performed The patient went into shock on the second postoperative day and died on the following day

At autopsy, the right auricle and ventricle and the left auricle were all large The mitral valve was fish-mouth in appearance and measured 2 0 by 0 2 centimeters It had been fractured at four points to a maximum depth of five millimeters Severe aortic stenosis was present Two small areas of fibrosis were found in the left ventricle

Case No 112 (C F N Y. Hospital History No 528008), a 40

year old woman was admitted because of severe exertional dyspnea fatigue and recurrent systemic and pulmonary emboli A left hemiparesis was present and preoperatively the patient experienced an acute paranoid reaction Auricular fibrillation was present The murmur of mitral stenosis a moderately loud murmur of mitral insufficiency and a soft murmur of aortic insufficiency were present Chronic heart failure was present The electrocardiogram showed no axis deviation a vertical heart and no hypertrophy pattern The heart was generally enlarged and there was pulmonary congestion in the x ray photograph of the chest. Therapy included a low salt diet digitalis and mercurials Preoperative New York Heart Classification was III C

At operation the mitral valve area was estimated to be between 0.5 and 1 0 sq cm in area Cardiac arrest occurred after evacuation of a left auricular clot and before the valve could be opened Despite prolonged efforts at resuscitation cardiac action did not resume

At autopsy the orifice of the unopened mitral valve was slit like and the mitral valve measured 3 0 by 1 5 cm The other valves were normal except for slight thickening of the chordae and leaflets of the tricuspid valve

Case No 159 (F F N Y Hospital History No 696179) a 45 year old woman was admitted because of progressive exertional dyspnea Auricular fibrillation was present. The murmur of mitral stenosis was heard In the x ray photograph of the chest the heart had a mitral configuration with an enlarged left auricle The blood pressure was elevated The hila of the lungs were congested pleural effusion was present on the left side The electrocardiogram showed right axis deviation a vertical heart, and no hypertrophy pattern Therapy consisted of digitalis An iron deficiency anemia was treated by transfusions Preoperatively the New York Heart Classification was III C

At operation the mitral valve area was estimated to be 1 0 sq cm in area. An attempt to wash a clot out of the left auricle was unsuccessful The splitting of the mitral valve was unsatisfactory and a tear in the auricular wall was sustained This was repaired Immediately postoperatively both lower extremities

were found to be cold The diagnosis of embolization to the bifurcation of the abdominal aorta was made The patient became cyanosed and died three hours afterwards It was thought that pulmonary embolization may have occurred terminally Permission for autopsy was not granted

Case No 188 (M M , N Y Hospital History No 710073) a 18 year old man, was admitted because of progressive exertional dyspnea, orthopnea, hemoptysis, and attacks of pulmonary edema. Normal sinus rhythm was present The only murmur heard was that of mitral stenosis Chronic heart failure was present An x-ray photograph of the chest showed a mitral configuration of the heart The lungs were congested The electrocardiogram showed right axis deviation, a vertical position and no hypertrophy pattern Therapy consisted of low salt diet, digitalis and mercurials Cardiac classification according to the New York Heart Criteria was III C There was a history of a peptic ulcer, last active 18 months before the operation

At operation the valve was estimated to be 1 0 sq cm in area and an adequate split was attained Cardiac arrest occurred and the patient died on the table

Autopsy revealed the following Boeck's sarcoid of the myocardium and lymph nodes Both auricles were large, both ventricles hypertrophied The tricuspid valve was thickened in one place, there was minimal fusion of two commissures of the aortic valve, the mitral leaflets were thickened The chordae tendineae of the mitral valve were fused

In retrospect, we are of the opinion that it was not possible to diagnose the Boeck's sarcoid before the operation The only finding that might have aroused suspicion was an eosinophilia We were aware of this, but were unable to assign a cause for it

Case No 199 (J M , N Y Hospital History No 399291), a woman 14 years of age, was dyspneic even when talking She experienced paroxysmal nocturnal dyspnea, hemoptysis, and several systemic emboli Severe congestive heart failure was present The New York Heart Cardiac Classification was IVD Auricular fibrillation was present Murmurs of mitral stenosis and insufficiency were heard An x-ray photograph of the chest showed

a large heart Pericardial calcification was identified Pulmonary congestion and an effusion in the right pleural cavity were seen The electrocardiogram was interpreted as showing right ventricular hypertrophy Therapy consisted of low salt diet digitalis mercurials ammonium chloride and diamox.

Valvulotomy had been recommended four years previously The patient went to another hospital where the operation of placing talcum powder into the pericardial sac was carried out

At operation the left auricle could not be entered because of dense pericardial adhesions The patient died in shock twelve hours postoperatively Permission for autopsy was not granted

Case No 224 (J S N Y Hospital History No 599744) a 20 year old woman was admitted because of severe exertional dyspnea, orthopnea hemoptysis and pulmonary edema Auricular fibrillation was present The murmur of mitral stenosis, loud murmurs of mitral insufficiency and tricuspid insufficiency and soft murmurs of aortic stenosis and insufficiency were heard. Congestive heart failure was present The electrocardiogram showed right axis deviation a vertical heart but evidence of left ventricular hypertrophy X ray photograph of the chest showed that the four cardiac chambers were enlarged The results of cardiac catheterization were interpreted as showing evidence of mitral stenosis mitral insufficiency and tricuspid insufficiency A rigid therapeutic regimen consisted of a low salt diet, digitalis mercurials and ammonium chloride The patient was thought to be terminal and was classified as IVD according to the New York Heart Criteria

During operation the patient was in borderline pulmonary edema. Practically no stenosis was found and mitral regurgitation was very marked After exploration the patient did poorly and died in shock and pulmonary edema ten days postoperatively

Autopsy showed evidence of rheumatic involvement of the tricuspid valve severe involvement of the mitral valve with one ruptured papillary muscle and fusion of the aortic cusps at the commissures The left ventricular wall was 20 mm in thickness. The lungs showed congestion consolidation and an infarct.

Case No 231 (A.S N Y Hospital History No 729677) a 49

year old woman, was incapacitated by severe dyspnea, fatigue orthopnea, pulmonary edema and paroxysmal nocturnal dyspnea Auricular fibrillation was present The blood pressure was 200/110 The murmur of mitral stenosis and soft murmurs of mitral insufficiency and aortic stenosis were heard Evidences of congestive failure were found The right ventricle, pulmonary artery, and left auricle were enlarged in the x-ray photograph of the chest Electrocardiogram showed no axis deviation, semi-vertical position of the heart, and no hypertrophy pattern was apparent Therapy before admission consisted of digitalis and mercurials, but was not considered to be optimal The New York Heart Cardiac Classification was III C

At operation, thrombi were found in the left auricle and some were washed out Tight stenosis of the mitral valve was found and a successful valvulotomy was thought to have been performed Heparin was started immediately after the operation and continued during the postoperative course based on frequent estimations of clotting time The patient first became hypotensive six hours postoperatively A stormy postoperative course was punctuated by recurrent episodes of hypotension The patient died in pulmonary edema on the tenth postoperative day

Autopsy showed the following Hypertrophy of all cardiac chambers, a stenotic mitral valve with the operative split, narrowed commissures of the aortic valve, multiple hemorrhages into the skin and subcutaneous tissues of the chest wall and into the pleural cavity, stomach and left lung Pulmonary edema, passive congestion of the viscera, and bilateral renal infarcts were present

Case No 247 (E I, N Y Hospital History No 723014) a 36 year old woman, was admitted because of progressive exertional dyspnea orthopnea, and hemoptysis Physical examination showed normal sinus rhythm, the murmur of mitral stenosis, a harsh systolic murmur loudest to the left of the sternum in the fifth interspace, and an accentuated pulmonic second sound, followed by a soft diastolic murmur The patient was not in congestive failure Chest x-ray showed evidence of enlargement of the pulmonary artery and of the right ventricle The lungs were

congested The electrocardiogram showed evidence of right ven tricular hypertrophy Catheterization diagnoses were 1 inter atrial septal defect 2 mitral stenosis 3 severe pulmonary hyper tension 4 partial anomalous pulmonary venous drainage into the right auricle and 5 a left superior vena cava Prior to coming to the hospital the patient had not been on an optimal thera peutic regimen The New York Heart Cardiac Classification was III C

At operation the small size of the left auricular appendage prevented exploration of the left auricle and operation was abandoned at this time It was decided to operate at a later date by entry through the right auricle Accordingly this was undertaken six months later Two interatrial septal defects a round moderately stenotic mitral valve and anomalous pul monary venous drainage were found A fairly adequate valvulo-tomy was performed After reacting favorably from the operation severe dyspnea cyanosis and complete heart block developed on the second postoperative day The blood pressure fell and the patient died on the third postoperative day

The autopsy findings were 1 a large interatrial septal defect and a rent in the auricular septum beneath it 2 fused com missures and thickened leaflets of the mitral valve 3 a large pulmonary artery right ventricle and right auricle 4 absence of the superior vena cava 5 a right innominate vein that entered the left auricle together with the right pulmonary vein 6 a left innominate vein that entered the coronary sinus 7 acute and chronic passive congestion of the lung with pulmonary edema

Case No 264 (G P N Y Hospital History No 610828) a 39 year old woman was completely incapacitated by exertional dyspnea orthopnea and paroxysmal nocturnal dyspnea Positive findings of the physical examination were auricular fibrillation the murmur of mitral stenosis a loud murmur of mitral insuffi ciency and moderately loud murmurs of tricuspid stenosis and insufficiency Congestive heart failure was present. An x ray photograph of the chest showed generalized cardiac enlargement congested lungs and right pleural effusion The results of catheter ization were interpreted as giving evidence of a tight mitral

year old woman, was incapacitated by severe dyspnea, fatigue, orthopnea, pulmonary edema and paroxysmal nocturnal dyspnea Auricular fibrillation was present The blood pressure was 200/110 The murmur of mitral stenosis and soft murmurs of mitral insufficiency and aortic stenosis were heard Evidences of congestive failure were found The right ventricle, pulmonary artery, and left auricle were enlarged in the x-ray photograph of the chest Electrocardiogram showed no axis deviation, semi-vertical position of the heart, and no hypertrophy pattern was apparent Therapy before admission consisted of digitalis and mercurials, but was not considered to be optimal The New York Heart Cardiac Classification was III C.

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stenosis, of mitral insufficiency, and of tricuspid insufficiency The electrocardiogram showed right axis deviation, a vertical heart and was without a hypertrophy pattern Therapy consisted of a low salt diet, digitalis, mercurials, ammonium chloride, and one thoracentesis The New York Heart Cardiac Classification was III C

At operation there was marked mitral insufficiency The mitral valve area was estimated to be 1 0 sq cm in area and it was thought that a successful valvulotomy was performed On the first postoperative day, the blood pressure fell, the patient went into shock and died the next day Permission for autopsy was not granted

Case No 300 (J M , N Y Hospital History No 762318) a 43 year old man, was admitted because of progressive exertional dyspnea, hemoptysis, and vascular accidents that probably represented cerebral emboli Positive findings of the physical examination were auricular fibrillation and moderately loud murmurs of mitral stenosis and tricuspid insufficiency Congestive heart failure was not present In an x-ray photograph of the chest the heart showed a mitral configuration, the lung fields were congested The electrocardiogram showed evidence of right ventricular hypertrophy The patient was on digitalis The New York Heart Cardiac Classification was III C Eight years previously, resection of the right parotid gland and a radical neck dissection were performed for cancer There had been no recurrence

At operation, there was mitral stenosis with mitral insufficiency The insufficiency was slightly increased by the valvulotomy, but a good opening was obtained A well-organized thrombus which was found in the left auricle was not disturbed during the operation Heparin was not administered Dicoumarol was started on the first postoperative day The patient died suddenly on the third postoperative day

At autopsy a recently formed ball valve thrombus occluded the mitral orifice The old thrombus had not bee[illegible]lged from the auricular wall

In summary, eight p[illegible] in cardiac [illegible]st being

TABLE 10

PATIENTS WHO HAD A MITRAL VALVULOTOMY AND WHO SURVIVING THE FIRST 30 POSTOPERATIVE DAYS, DIED DURING THE FOLLOW UP PERIOD

Case No. N. Y. Hospital History No.	Age Sex	Preoperative Classification	Reason for Operat	Preoperative Valvular Diagnosis	Size of Valve Before Operation	Size of Valve After Operation	Adequacy of Split	Valve Calcification	Comments on Operation	Postoperative Course to Death	Cause of Death	Months Post-operatively
Case No. 109 G. T. 676380	29 male	III C	Progressive dyspnea, hemoptysis	M. S., M. I.	1.5 cm²	3.0 cm²	Good	⊕	Moderate M. I. increased Surgeon gave guarded prognosis.	Moderately improved for 21 mos. Sudden increase in heart failure. Much worse for last month.	Sudden death with heart failure	22
Case No. 1 3 J. B. 157883	53 male	IVD	Incapacitating dyspnea	M. S., M. I., T. I.	1.3 cm²	3.0 cm²	Good	⊕	Marked M. I.	Continuing heart failure never improved.	Heart failure	2 mos. and 3 weeks.
Case No. 128 P. A. 681708	49 female	IVD	Progressive dyspnea and fatigue	M. S., M. I., T. I.	1.5 cm²	3.0 cm²	Good	+	Moderate M. I. increased somewhat by the operation	Markedly improved for 1 yr. Then relapsed but not to preoperative status. Died suddenly 17 mos. after operation due to pneumonia and pulmonary edema.	Pneumonia, pulmonary edema	17
Case No. 155 R. K. 644766	59 female	III D	Progressive dyspnea and fatigue. Pulmonary edema	M. S., M. I.	less than 1 cm²	2 cm²	Fair	+	Slight M. I.	Never improved but had concomitant ovarian cancer which caused death.	Metastatic ovarian cancer	8
Case No. 245 R. R. 235853	38 female	IVD	Progressive dyspnea and fatigue	M. S., A. I., T. I.	1.2 cm²	3 cm²	Fair	⊕	Slight M. I. unaltered by operation, marked distortion of valve.	Unchanged for 7 mos. Then pneumonia and pulmonary infarction. Worse for last 2 months.	Heart failure	9

=No autopsies were performed in these cases
+=moderate calcification
⊕=marked calcification

also in shock One of these had associated aortic valvular disease and another adhesive pericarditis There were two cardiac arrests on the table, one of which was in a patient who also had Boeck's sarcoid One patient died with arterial and possible pulmonary emboli three hours after operation Another patient at autopsy was found to have a ball valve thrombus occluding the mitral orifice

To recapitulate

Two patients died on the operating table, two patients died within 24 hours after operation, eight patients died within the first month after operation

PATIENTS WHO, HAVING HAD MITRAL VALVULOTOMY AND SURVIVED THE FIRST 30 POSTOPERATIVE DAYS, DIED DURING THE FOLLOW UP PERIOD

Nine patients died during the follow up period after surviving the immediate postoperative course Four patients were explored but an operation on the mitral valve was not done (Case Nos 101, 168, 202, 260) Three of these four patients had been found at exploration to have marked mitral insufficiency without mitral stenosis In the fourth patient a thrombus in the left auricular appendage prevented operative entry of the left auricle (see p 87)

Thus 5 patients who had operations on the mitral valve died in the follow up period after surviving the immediate postoperative course (Table 10) The histories of these patients are summarized

In Case No 109 (G T, N Y Hospital History No 676380) a 29 year old man with the murmurs of mitral stenosis and insufficiency, a good split was obtained at operation but with some increase of the mitral insufficiency He was markedly improved, but died suddenly 22 months postoperatively, shortly after a sudden increase in congestive failure Permission for autopsy was not given

Case No 123 (J B, N Y Hospital History No 457883) a 53 year old man with the clinical diagnoses of mitral stenosis, mitral insufficiency and tricuspid insufficiency, was classified as IV D The patient had intractable congestive heart failure Electrocardiograms showed runs of ventricular paroxysmal tachycardia

Mitral valvulotomy was performed because of the patient's steady downhill course Marked mitral insufficiency was found at operation a good opening was made however in the valve because it was also moderately stenosed The patient's status was unchanged and he died 3 months after operation

In Case No 128 (F.A N Y Hospital History No 681708) a 49 year old woman with the murmurs of mitral stenosis mitral insufficiency and aortic insufficiency a good split of the mitral valve was obtained at operation but with detectable increase of the mitral insufficiency Seventeen months after operation and five months after the occurrence of persistent congestive heart failure she died during an episode of pneumonia and pulmonary edema Both the patient and her family thought that operation had been of benefit for the first year

In Case No 155 (R K N Y Hospital History No 644766) a 55 year old woman with the murmurs of mitral stenosis and insufficiency a moderately satisfactory split of a tight mitral valve was obtained at operation The patient's condition was however unchanged She died eight months postoperatively of metastatic ovarian carcinoma which in retrospect had probably been present at the time of the valvulotomy The patient also had arteriosclerotic heart disease

Case No 245 (R R N Y Hospital History No 235852) a 33 year old woman with the clinical findings of mitral stenosis aortic insufficiency and tricuspid insufficiency had a fairly satisfactory split at operation with no increase in mitral insufficiency The severity of congestive heart failure was unchanged however postoperatively She survived an episode of lobar pneumonia at 7 months and a pulmonary embolus at 8 months but died in the ninth postoperative month The patient was not in The New York Hospital when she died and permission for autopsy was not obtained

PATIENTS WHO HAD A THORACOTOMY OR CARDIOTOMY WITHOUT OPERATION ON THE MITRAL VALVE

In five patients the operation was limited to exploratory thoracotomy The reasons the left auricle was not entered were

as follows 1) An extensive clot in the atrial appendage (Case No 101 (A R, N Y Hospital History No 673607)), 2) A calcified left auricular wall (Case No 103 (R P, N Y Hospital History No 668782)), 3) An obliterated left auricular appendage (Case No 133 (M M, N Y Hospital History No 671615)), 4) Dense scarring of the pericardium due to a previous operation in which talcum powder was put into the pericardial sac (Case No 199 (J M, N Y Hospital History No 399294)), and 5) A left auricular appendage that was scarred and contracted (Case No 214 (E I, N Y Hospital History No 723014)) Two of these patients died in the hospital (Case No 103 and Case No 199) and one (Case No 101) died 20 months afterwards One case (Case No 214) had a second operation later (See Section II, p 82, Case No 247)

Nine patients had a cardiotomy without operation on the mitral valve Case No 115 (C P, N Y Hospital History No 677901), Case No 141 (A H, N Y. Hospital History No 687231), Case No 168 (F DeB, N Y Hospital History No 703421), Case No 182 (A M, N Y Hospital History No 483861), Case No 202 (A C, N Y Hospital History No 702287), Case No 215 (N O, N Y. Hospital History No 725686), Case No 224 (J S, N Y Hospital History No 599744), Case No 260 (M B, N Y Hospital History No 747190), Case No 263 (J K, N Y Hospital History No 746733) In five of these the mitral valve was not stenosed Four patients had slight mitral stenosis, but a valvulotomy was not attempted because of the danger of increasing mitral insufficiency There was marked mitral insufficiency in all nine patients The knowledge that mitral insufficiency was present and that the exploration might show it to be considerable was appreciated preoperatively in eight of these patients In one patient significant mitral insufficiency was not suspected preoperatively The characteristic physical signs were not present There was no evidence of mitral insufficiency in the cardiac catheterization data Of these nine patients with marked mitral insufficiency and with little or no stenosis, the apical systolic murmur was loud in seven, moderately loud in one, and absent in one

The course in six patients appeared to be unchanged by the

exploratory operation one dying 16 months postoperatively two were worse one dying 10 months the other six months post operatively One patient died 10 days after operation

Thus two of the five patients who had an exploratory thoracotomy died during the immediate postoperative period One other patient died during the follow up period Of the nine patients who had cardiotomies without operation on the mitral valve one died in the immediate postoperative period and three died during the follow up period These data emphasize the danger to patients with severe rheumatic heart disease and large hearts in whom mitral insufficiency is found to be the predominant lesion at the time of exploration even though there is significant or correctable mitral stenosis These patients often have a stormy postoperative course and the mortality rate is high It is to be emphasized that exploration is not to be undertaken without serious consideration of the hazards in patients in whom the relative importance of the two valvular lesions is in serious question before the operation Nevertheless if the stenosis can be relieved even in the presence of significant mitral insufficiency the results are often most gratifying

Section III

EVALUATION OF RESULTS IN THE 170 PATIENTS WHO HAD A MITRAL VALVULOTOMY AND SURVIVED THE IMMEDIATE POSTOPERATIVE PERIOD

OVER-ALL RESULTS WITH RESPECT TO BENEFIT

As judged by the criteria described previously (Part I, Section II, p 17) 65 3 per cent of the patients (111 cases) were markedly improved, 14 1 per cent (24 cases) were moderately improved, 12 9 per cent (22 cases) were unchanged, 4 1 per cent (7 cases) were unchanged after an initial improvement, 0 6 per cent (1 case) was worse after an initial improvement, 0 6 per cent (1 case) was worse after being unchanged, and 2 4 per cent (4 cases) were worse

TABLE 11

Over-all Results With Respect to Benefit from Mitral Valvulotomy in 170 Patients

	Number of Cases	*Per Cent of Total Improved*
Markedly Improved	111	65 3
Moderately Improved	24	14 1
Unchanged	22	12 9
Improved going to Unchanged	7	4 1
Improved going to Worse	1	0 6
Unchanged going to Worse	1	0 6
Worse	4	2 4
Total Number of Cases	170	100 0

immediately after operation (Table 11) Accordingly 79 4 per cent of the patients were improved by mitral valvulotomy 16 5 per cent unchanged and 3 6 per cent worse

IMPROVEMENT WITH RESPECT TO NEW YORK HEART CRITERIA FOR FUNCTIONAL CLASSIFICATION

The criteria established by the New York Heart Association were used in this analysis *(p 17 and p 26)*

The improvement rate in the three Classes who were operated upon was as follows In Class II 83 3 per cent (44 4 per cent markedly improved 38 9 per cent moderately improved) Class IV 76 1 per cent (61 8 per cent markedly improved 14 3 per cent moderately improved)

Approximately the same percentages of the three Classes were not improved by the operation (16 7 per cent 17 6 per cent and 14 3 per cent) One patient in Class II five in Class III and one in Class IV were initially improved and then reverted to their preoperative status.

No patients in Class II were made worse by the operation

TABLE 12

IMPROVEMENT IN THE PATIENTS CLASSIFIED PREOPERATIVELY ACCORDING TO THE NEW YORK HEART CRITERIA

Grade of Improvement	*Number of Cases*				*Total in all Classes*
	Class I	*II*	*III*	*IV*	
++	1	8	89	13	111
+	0	7	14	3	24
0	0	2	18	2	22
+ → 0	0	1	[illegible]	1	7
+ → W	0	0	1	0	1
0 → W	0	0	0	1	1
W	0	0	3	1	4
Total number of cases	1	18	130	21	1 0

See Part I page 17

Preoperatively many of these patients were able to be moderately active, but it was thought that operation might prevent further and more serious deterioration Eight of 18 patients in this category had preoperative emboli Six patients in Class III and Class IV were made worse by operation, one after being improved for 22 months, and another after having been unchanged for seven months The number of patients in each category is listed in Table 12

Recurrent episodes of pulmonary and systemic emboli were indications for operation in 24 per cent of patients (38 out of 159) Some of these cases were not markedly disabled as estimated by the criteria of the functional classification of the New York Heart Association, but most had residua from the emboli

The operative results as estimated by the New York Heart Association Criteria in patients who had had preoperative emboli were similar to those who had not had preoperative emboli

IMPROVEMENT AND RHYTHM

Eighty-nine patients (52 4 per cent) had normal rhythm, and 81 (47 6 per cent) auricular fibrillation

A higher percentage of those patients with normal rhythm was improved compared to those with auricular fibrillation (87 7 and 70 4 per cent, respectively) (Table 13) Auricular fibrillation

TABLE 13

Improvement and Rhythm

Grade of Improvement*	*89 Cases Exhibiting Normal Rhythm*	*81 Cases Exhibiting Auricular Fibrillation*
++	61	50
+	17	7
0	9	13
+ → 0	2	7
+ → W	0	1
0 → W	0	1
W	0	1

* See Part I page 17

may be considered as evidence of more advanced or of longer standing disease

Of those patients with normal rhythm 12 3 per cent and of those with auricular fibrillation 22 3 per cent were unchanged or were evaluated as unchanged after an initial improvement No patients with normal rhythm were made worse by operation on the other hand 7 3 per cent of those with auricular fibrillation were made worse one after an initial improvement of twenty two months duration and one after being in an unchanged status for seven months

Thus the results of the operation are more favorable in the presence of normal rhythm

In eleven patients who had normal rhythm before operation the rhythm had changed to auricular fibrillation at the time of the last follow up examination Seven of these patients were improved (five markedly) in three the status was unchanged the other patient was classified as unchanged after an initial improvement

Two patients who had auricular fibrillation before operation reverted to normal rhythm during the follow up period One patient was markedly improved and the other one unchanged by operation

IMPROVEMENT AS TO SEX

Of the 170 patients analyzed 74 7 per cent were females 25 3 per cent were males. A higher percentage of females than males were improved namely 81 9 per cent females and 72 1 per cent males (Table 14)

TABLE 14

IMPROVEMENT AND SEX

Sex	*Grade of Improvement*		
	Markedly Improved	*Moderately Improved*	*Total Improved*
	Per Cent	*Per Cent*	*Per Cent*
Females	67 7	14.2	81.9
Males	58 1	14.0	72.1

See Part 1 page 17

It appeared that

1 17 3 per cent (22 cases) of the females were classified as unchanged, five after an initial improvement

2 16 3 per cent (7 cases) of the males were classified as unchanged, two after an initial improvement

3 0 8 per cent (1 case) of the females was worse after the operation This patient's status had been at first unchanged by operation

4 11 6 per cent (5 cases) of the males were made worse by operation, one after an initial improvement

It is apparent that a lower percentage of the males was improved by mitral valvulotomy than females, and also a higher percentage was either unchanged or worse

TABLE 15

IMPROVEMENT AND AGE

Age Groups	*No of Cases*	*Grade of Improvement**						
		++	+	0	+→0	+→W	0→W	W
		%	%	%	%	%	%	%
10 20	1	0 0	0 0	100 0	0 0	0 0	0 0	0 0
21-30	29	72.5	17 3	3 4	3 4	3 4	0 0	0 0
31-40	63	79 2	11 0	3 3	3 3	0 0	1 6	1 6
41-50	56	53 7	17 7	19 6	5 1	0 0	0 0	3 6
> 50	21	47 6	9.5	33.3	4 8	0 0	0 0	4.8

* See Part I page 17

IMPROVEMENT AS TO AGE

There was only one patient in the 10 to 20 years old age group and this one was unimproved by operation (Table 15) In the age groups of 21 to 30 and 31 to 40 there were a total of 92 patients and among these were found the highest percentage of "improved" and the lowest percentage of "unchanged" or "worse" categories, as compared with the other age groups In the 41 to 50 years age group and also in those patients who were

over 50 years old (making a total of 77 patients) a lower per centage was improved and a higher percentage was unchanged or worse as compared to the groups just mentioned Thus the results are more favorable in the younger patients nevertheless 57 to 71 per cent of patients in the age group after 40 years of age are also benefited by the operation

PRESENTING SYMPTOMS AND IMPROVEMENT

In the 170 patients analyzed the major presenting symptom was pulmonary edema in 28 8 per cent paroxysmal nocturnal dyspnea without frank pulmonary edema in 18 8 per cent and both paroxysmal nocturnal dyspnea and pulmonary edema in 8 2 per cent. Pulmonary emboli had occurred in 10 6 per cent peripheral emboli in 17 6 per cent progressive dyspnea in 96 5 per cent, progressive easy fatigability in 44 7 per cent and hemoptysis in 31 2 per cent

Similar percentages of patients were improved (both markedly and moderately so) irrespective of the presenting symptoms (Table 16) The lowest percentage of improvement namely 80 2 per cent, was recorded in those patients who had progressive easy fatigability as a major presenting symptom The highest percentage of improvement namely 87 8 per cent was seen in those patients who had frank pulmonary edema.

In patients with frank pulmonary edema and with pulmonary emboli the lowest percentage rates of unchanged by the opera tion were recorded (6 1 per cent, 5 6 per cent respectively) and those with progressive fatigue had the highest percentage rate in the unchanged categories (18.5 per cent)

The percentage of patients who were made worse by the operation ranged from none in those who had both paroxysmal noc turnal dyspnea and pulmonary edema to 11 0 per cent in those who had one or more pulmonary emboli

TABLE 16

PRESENTING SYMPTOMS AND IMPROVEMENT

Grade of* Improvement	Presenting Symptoms							
	Pulmonary Edema	Paroxysmal Nocturnal Dyspnea	Paroxysmal Nocturnal Dyspnea & Pulmonary Edema	Pulmonary Emboli	Peripheral Embolic Phenomena	Progressive Dyspnea	Progressive Easy Fatig-Ability	Significant Hemoptysis
	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
++	75.6	65.6	71.5	66.7	60.0	65.3	60.5	81.1
+	12.2	18.8	11.3	16.7	23.3	15.8	19.7	5.6
0	2.0	9.1	7.1	0.0	13.3	11.6	13.2	3.8
+ → 0	1.1	3.1	7.1	5.6	0.0	4.3	5.3	5.7
+ → W	0.0	3.1	0.0	0.0	0.0	0.6	0.0	1.0
0 → W	2.0	0.0	0.0	11.0	0.0	0.6	1.3	1.9
W	1.1	0.0	0.0	0.0	3.3	1.8	0.0	0.0

*See Part I page 17

IMPROVEMENT AND PREOPERATIVE DIAGNOSIS OF VALVE LESIONS

(With comments on (1) preoperative murmurs in patients found to have marked mitral insufficiency at operation (2) the operative results in patients found to have marked mitral insufficiency at operation)

Fifty two patients had pure mitral stenosis without other valve lesions as the preoperative diagnosis In the other 118 patients other valve lesions were thought to be present but it was our opinion that mitral stenosis was the predominant lesion (Table 8)

Fifty two patients had pure mitral stenosis In this group 68 4 per cent were markedly improved by mitral valvulotomy 21 2 per cent moderately improved 7 7 per cent unchanged 7 7 per cent unchanged after an initial improvement. None of the patients were made worse

Three patients had the murmurs of mitral stenosis and tri cuspid stenosis One was markedly improved by mitral valvulotomy one was moderately improved and one was unchanged Operation for tricuspid stenosis was not carried out in any patient in this second 200 patients

Fifty-one patients had mitral stenosis and slight mitral insufficiency only In this group 64 7 per cent were markedly improved by mitral valvulotomy 9 8 per cent moderately improved 15 7 per cent unchanged 1 9 per cent unchanged after an initial improvement 1 9 per cent worse after an initial improvement, and 6 per cent worse The percentage markedly improved was similar in patients with pure mitral stenosis and in those with mitral stenosis and moderate mitral insufficiency On the other hand a smaller percentage of patients with mitral stenosis and mitral insufficiency was moderately improved a higher percentage was unchanged and four patients were made worse one after an initial improvement Four of the six patients who were made worse by operation had mitral stenosis and mitral insufficiency as the only valve lesions preoperatively

Nine patients had mitral stenosis and slight aortic insufficiency only Seven were markedly improved and two were moderately

improved by mitral valvulotomy Thus the presence of slight aortic insufficiency does not preclude a good result The pulse pressure in these patients varied between 36 and 70 mm of mercury, the average being 49 mm of mercury In none of the patients was aortic insufficiency thought to be of major significance With respect to the electrocardiograms none of the patients with mitral stenosis and aortic insufficiency had left axis deviation, horizontal position, or left ventricular hypertrophy patterns in the electrocardiograms Five patients had right axis deviation and four no axis deviation Five had vertical positions of the heart, two semivertical, one intermediate, and one indeterminate Patterns of right ventricular hypertrophy were present in two patients and hypertrophy patterns were not apparent in seven

Seven patients had mitral stenosis, mitral insufficiency and aortic insufficiency only Marked improvement occurred after mitral valvulotomy in 85 7 per cent, 14 3 per cent were unchanged after initial improvements

There were no patients with mitral stenosis, mitral insufficiency, aortic stenosis, aortic insufficiency

Of the 43 patients with tricuspid insufficiency, with other murmurs (Table 8), 65 2 per cent were markedly improved by mitral valvulotomy, 11 6 per cent were moderately improved, 16 3 per cent were unchanged, 2 3 per cent were unchanged after an initial improvement, 4 6 per cent were worse, one after having been in the "unchanged" category

Thus the results of mitral valvulotomy in the presence of a preoperative clinical diagnosis of tricuspid insufficiency were rather similar to results in patients with murmurs of mitral stenosis alone, or mitral stenosis and mitral insufficiency alone

Of four patients with mitral stenosis and aortic stenosis, three were markedly improved and one was unchanged by mitral valvulotomy An operation on the aortic valve was not performed in this group of patients

Eighty-seven of the 170 patients in this analysis (51 2 per cent) had the clinical diagnosis of mitral insufficiency together with other murmurs Marked improvement from mitral valvulotomy occurred in 64 5 per cent of the patients, moderate improvement

in 6 9 per cent 18 4 per cent were unchanged 3 4 per cent were unchanged after initial improvement 1 1 per cent were worse after initial improvement 1 1 per cent were worse after being unchanged and 4 6 per cent were worse The percentage of markedly improved patients is not greatly different from that in patients with the preoperative clinical diagnosis of mitral stenosis alone or mitral stenosis with mitral insufficiency On the other hand a smaller percentage was moderately improved A higher percentage was in the unchanged category All of the patients made worse by mitral valvulotomy had mitral insufficiency diagnosed clinically before operation Thus the clinical diagnosis of mitral insufficiency does not preclude a favorable outcome but on the other hand it increases the likelihood of the patient being unchanged or worse after operation

Of the 14 patients in whom marked mitral insufficiency was found at operation two did not have the murmur of mitral insufficiency when evaluated preoperatively Of the 12 patients who had significant mitral insufficiency at operation but also evidence of mitral insufficiency preoperatively five had loud five moderately loud and two had soft systolic murmurs

Since two of the patients were found at operation to have marked mitral insufficiency which was not suspected clinically beforehand it turns out that 12 of the 87 patients (13 8 per cent) having mitral insufficiency diagnosed before operation had marked insufficiency at operation as evaluated by the surgeon Of these 12 cases 33 3 per cent were markedly improved 16 7 per cent moderately improved 41 7 per cent unchanged 8 3 per cent worse Thus the operative result of mitral valvulotomy when significant mitral insufficiency was found at operation was much less favorable compared to the results in the whole group of 170 patients

ASCHOFF BODIES IN LEFT AURICULAR APPENDAGE AND IMPROVEMENT

It was possible to make this analysis in 167 patients Fifty two patients had Aschoff bodies in the biopsy of the auricular appendage Of these 71 2 per cent were markedly improved by mitral valvulotomy 13 6 per cent moderately improved 9 6 per cent

unchanged, 3.7 per cent unchanged after initial improvement, 1.9 per cent worse after initial improvement, none of the patients were made worse.

Aschoff bodies were not found in the auricular appendages of 115 patients. Of these, 61.7 per cent were markedly improved by mitral valvulotomy, 14.8 per cent moderately improved, 14.8 per cent unchanged, 4.3 per cent unchanged after an initial improvement, none were worse after initial improvement, 0.9 per cent were worse after being unchanged, and 3.5 per cent were worse directly after the operation.

Accordingly, the results of mitral valvulotomy were somewhat better in the 167 patients analyzed in this regard in those who had Aschoff bodies. This conclusion differs from the results of the similar analysis in the first one hundred cases (Part I, Section III, p. 31). The inference to be drawn from this is that the presence of Aschoff bodies does not influence the outcome which may be expected from the mitral valvulotomy. It is also apparent that the auricular appendage yields a sample from one area only of heart muscle.

IMPROVEMENT AND ESTIMATED SIZE OF MITRAL VALVE AT OPERATION

Improvement in all 170 patients was analyzed in relation to the surgeon's estimate of valve size at operation. Tight mitral stenosis was defined as a valve that admitted only an index finger tip. This corresponds to an area equal to or less than one square centimeter. Moderate mitral stenosis refers to a valve area greater than one, but less than two square centimeters. A valve of this size did not admit the surgeon's index finger. Little or no stenosis refers to a valve of two square centimeters or over in area and admitting an index finger.

Of 170 cases, 64.1 per cent had tight stenosis, 34.1 per cent moderate stenosis, 1.8 per cent little or no stenosis.

Of the 109 patients with tight stenosis, 73.3 per cent were markedly improved by mitral valvulotomy, 14.8 per cent moderately improved, 8.2 per cent unchanged, with an additional 2.8 per cent unchanged after an improvement. One patient with tight stenosis was worse after operation (0.9 per cent).

Of the 58 patients with moderate stenosis 53 4 per cent were markedly improved by mitral valvulotomy 13 8 per cent were moderately improved 17 2 per cent were unchanged, with an additional 6 9 per cent unchanged after initial improvement 1 7 per cent were worse after improvement 1 7 per cent worse after being unchanged and 5 3 per cent were worse directly after the operation

In the three patients who were found to have at exploration little or no stenosis their status was unchanged by operation

It appears that patients with tight mitral stenosis have more likelihood for improvement by mitral valvulotomy than those with moderate stenosis Moreover more patients remained unchanged or were made worse in the moderate stenosis category The operation did not benefit patients who were found at operation to have little or no stenosis

IMPROVEMENT AND ESTIMATED ADEQUACY OF OPERATIVE SPLIT AT TIME OF OPERATION

(With comments on use of the valvulotomy knife)

The size of the valve and adequacy of the split were estimated by the surgeon at operation The definition of the size of the valve opening was discussed in Part One p 32

Of the 169 patients analyzed 160 (95 per cent) had satisfactory splits Of these 83 7 per cent had some improvement after mitral valvulotomy 13 8 per cent remained unchanged and 2 5 per cent were worse Of the nine patients with unsatisfactory splits 77 8 per cent remained in unchanged status 22 2 per cent were made worse

Of the 110 patients markedly improved and the 24 moderately improved all had satisfactory splits of the valve Of the 22 patients unchanged by operation 16 had satisfactory and six had unsatisfactory splits Of the seven patients who regressed to an unchanged status after an improvement six had good splits Of the six cases made worse by the operation some after being improved or having remained unchanged four had adequate splits

Of the 108 patients with tight mitral stenosis and good splits 74 1 per cent were markedly improved by mitral valvulotomy

14.8 per cent were moderately improved, 7.4 per cent were unchanged and an additional 2.8 per cent returned to the unchanged status after initial improvement. One patient (0.9 per cent) was made worse. The combination of tight mitral stenosis and a good split results in a more favorable outcome from operation, compared to the general average in the 170 cases analyzed as a whole.

In the 57 patients with moderate stenosis who were in the analysis, there was a higher percentage of cases with poor "splits" and a less favorable outcome of the operation. Good splits were secured in 87.7 per cent of the 57 cases, while poor splits occurred in 12.3 per cent. Of those patients with good splits, 60 per cent were markedly improved, 16 per cent moderately improved, 12 per cent remained unchanged, 6 per cent regressed to the unchanged status after initial improvement, and 6 per cent were worse, one of these having first been improved. In the patients with moderate stenosis and poor splits, none were improved, five were estimated as unchanged, one after initial improvement, and two were worse, one after having been in the unchanged category at first.

TABLE 17

THE PERCENTAGE OF PATIENTS IN EACH CATEGORY OF CALCIFICATION FOUND IN EACH GRADE OF IMPROVEMENT

Grade of Improvement*	*Marked Calcification*	*Moderate Calcification*	*No Calcification*
	Per Cent	*Per Cent*	*Per Cent*
+ +	65.5	57.8	73.5
+	10.4	15.5	11.9
0	13.9	11.1	11.9
+ → 0	0.0	8.1	2.7
+ → W	3.1	0.0	0.0
0 → W	3.1	0.0	0.0
W	[illegible]	[illegible]	0.0
Total number of cases	29(100%)	71(100%)	[illegible](100%)

* See Part I, page 17

TABLE 18

THE PERCENTAGE OF PATIENTS IN EACH GRADE OF IMPROVEMENT FOUND IN EACH CATEGORY OF CALCIFICATION

Grade of Calcification	*Grade of Improvement*						
	++	+	0	+ → 0	+ → W	0 → W	W
	Per Cent	*Per Cent*	*Per Cent*	*Per Cent*	*Per Cent*	*Per Cent*	*Per Cent*
Marked	18.3	14.3	19.1	0.0	100	100	25
Moderate	39.1	52.4	47.6	85.7	0	0	75
None	42.3	33.3	33.3	14.3	0	0	0
Total number of cases	104(100%)	91(100%)	91(100%)	7(100%)	1(100%)	1(100%)	4(100%)

See Part I page 17

14 8 per cent were moderately improved, 7 4 per cent were unchanged and an additional 2 8 per cent returned to the unchanged status after initial improvement One patient (0 9 per cent) was made worse The combination of tight mitral stenosis and a good split results in a more favorable outcome from operation, compared to the general average in the 170 cases analyzed as a whole

In the 57 patients with moderate stenosis who were in the analysis, there was a higher percentage of cases with poor "splits" and a less favorable outcome of the operation Good splits were secured in 87 7 per cent of the 57 cases, while poor splits occurred in 12 3 per cent Of those patients with good splits, 60 per cent were markedly improved, 16 per cent moderately improved, 12 per cent remained unchanged, 6 per cent regressed to the unchanged status after initial improvement, and 6 per cent were worse, one of these having first been improved In the patients with moderate stenosis and poor splits, none were improved, five were estimated as unchanged, one after initial improvement, and two were worse, one after having been in the unchanged category at first

TABLE 17

THE PERCENTAGE OF PATIENTS IN EACH CATEGORY OF CALCIFICATION FOUND IN EACH GRADE OF IMPROVEMENT

Grade of Improvement*	*Marked Calcification*	*Moderate Calcification*	*No Calcification*
	Per Cent	*Per Cent*	*Per Cent*
++	65.5	57 8	73.5
+	10 4	15 5	11 9
0	13 9	14 1	11 9
+ → 0	0 0	8 4	2 7
+ → W	3 4	0 0	0 0
0 → W	3 4	0 0	0 0
W	3 4	4 2	0 0
Total number of cases	29(100%)	71(100%)	59(100%)

* See Part I page 17

TABLE 18

THE PERCENTAGE OF PATIENTS IN EACH GRADE OF IMPROVEMENT FOUND IN EACH CATEGORY OF CALCIFICATION

Grade of Calcification	Grade of Improvement						
	++	+	0	+ → 0	+ → W	0 → W	W
	Per Cent	*Per Cent*	*Per Cent*	*Per Cent*	*Per Cent*	*Per Cent*	*Per Cent*
Marked	18.3	14.3	19.1	0.0	100	100	25
Moderate	39.4	52.4	47.6	85.7	0	0	75
None	42.3	33.3	33.3	14.3	0	0	0
Total number of cases	101(100%)	21(100%)	21(100%)	7(100%)	1(100%)	1(100%)	4(100%)

See Part I page 1

Of the three patients with little or no stenosis all remained unchanged clinically by operation Two of the three had good splits Both of these patients had valve areas estimated at 2 0 sq cm and in both there was considerable mitral insufficiency

Valvulotomies and various knives have been of modest assistance in those instances where finger fracture has not been adequate The thimble of W W Glenn, M D has been used effectively on occasion It is estimated that some type of intracardiac instrument was used in about 10 per cent of the second and third hundred patients

IMPROVEMENT WITH RESPECT TO CALCIFICATION IN THE MITRAL VALVE

(With comments on the relationship of (1) Calcification to adequacy of the split obtained by the surgeon, (2) Calcification and sex, (3) Mitral insufficiency found at operation, calcification, and sex)

Statements concerning calcification of the mitral valve as palpated by the surgeon at operation was made in the operative notes in 159 patients Three categories were listed Marked, moderate, and no calcification

Of the 159 patients, 29 (18 2 per cent) had marked calcification, 71 (44 7 per cent) had moderate calcification, 59 (37 1 per cent) had no calcification (Table 17)

The percentage of patients improved was higher, namely 85 4 per cent (73 5 + 11 9), in those with no calcification than in those with marked and moderate calcification (Table 17) No patients in the "no calcification" group were made worse by mitral valvulotomy A greater percentage of patients with marked calcification was worse after operation than those in other categories

The less the calcification, the better is the chance for a good result from mitral valvulotomy (Table 18)

It appears that

1 6 9 per cent of cases with marked calcification, 7 0 per cent of cases with moderate calcification, and 3 4 per cent of cases with no calcification had poor splits It is concluded that the percentage of patients with poor splits was about twice as high in those with calcification than in those without calcification

2 Of the nine patients with poor splits two had marked calcification five moderate calcification two had no calcification

3 34 9 per cent (15 of 43 patients) of males had marked calcification

4 48 8 per cent (21 of 43 patients) of males had moderate calcification

5 16 3 per cent (7 of 43 patients) of males had no calcification

6 7 1 per cent (14 of 116 patients) of females had marked calcification

7 43 1 per cent (50 of 116 patients) of females had moderate calcification

8 48 8 per cent (52 of 116 patients) of females had no calcification

It is apparent that the incidence of calcification is higher in males

Thirteen patients with marked mitral insufficiency as estimated by the surgeon at operation were available for analysis Nine were males Of these nine males seven had marked calcification two had moderate calcification there was not a single male with mitral insufficiency who did not have calcification

Of the nine patients with marked mitral insufficiency in males (all of whom had calcification) three were markedly improved (all had marked calcification) by mitral valvulotomy two moderately improved the status in three remained unchanged one patient was worse It appears that the presence of mitral insufficiency and calcification does not preclude a good result from mitral valvulotomy in these male patients

The degree of calcification seems to be associated with the (1) duration of the rheumatic heart disease (2) the age of the patient, (3) sex and (4) occupation

The greatest degree of calcification was found in male patients with a long history of rheumatic heart disease whose occupation included heavy labor

An x ray photograph of the chest showing calcification in the region of the mitral valve is reproduced in Figure 7 and a line drawing of this in Figure 8 The presence of calcification was confirmed at operation

RELATION OF MITRAL INSUFFICIENCY FOUND AT OPERATION AND ITS INCREASE, DECREASE, OR LACK OF CHANGE BY THE OPERATION TO IMPROVEMENT

In 139 patients the operative note gave definite information about the presence or absence of mitral insufficiency, both before and after valvulotomy

Seventy-two patients were thought by the surgeon to have no mitral insufficiency before valvulotomy In 57 of these, none

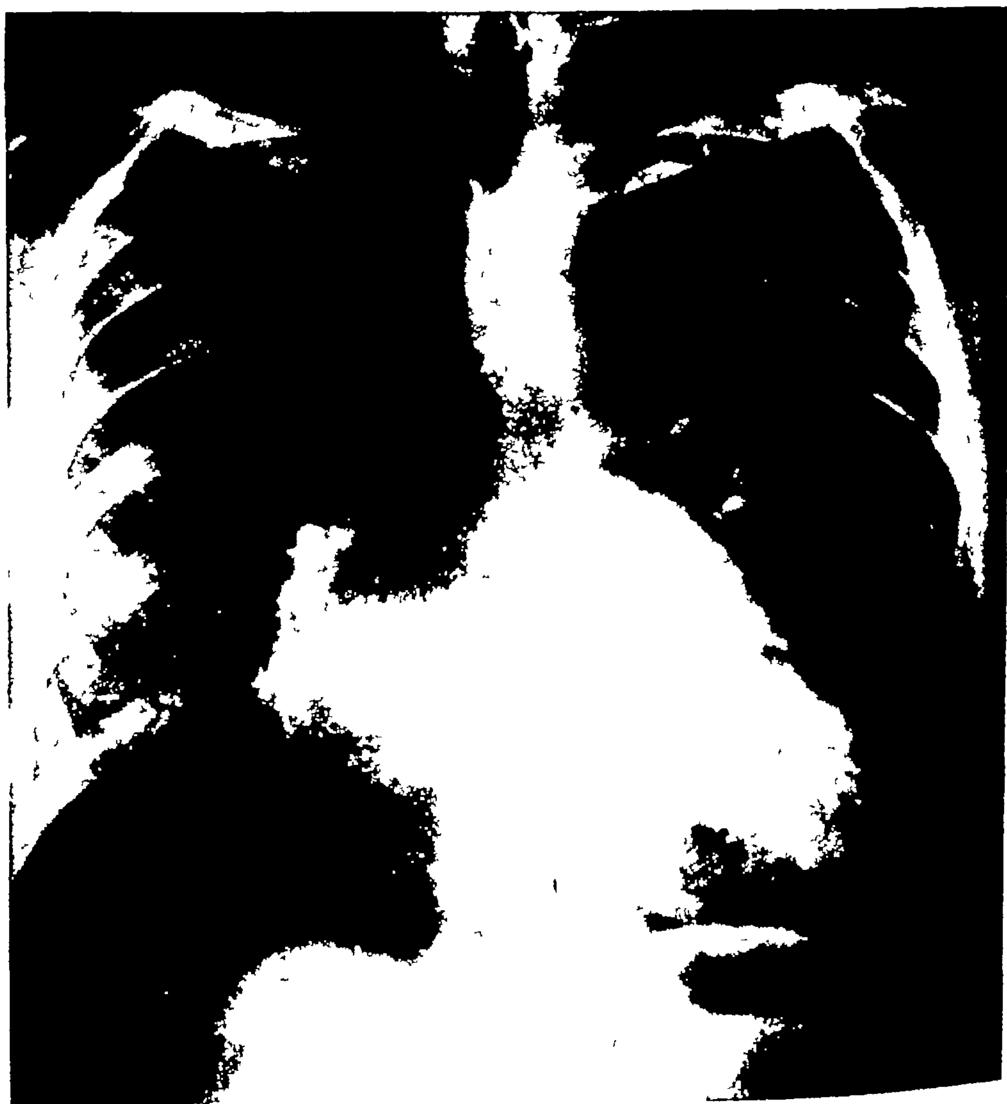


Figure 7 In this figure is reproduced an overpenetrated 2 meter x ray photograph of the chest to show calcification (see arrow) in the region of the mitral valve in Case No 3

was induced by operation Of these 57 forty two were markedly improved one was markedly improved only later to regress to an unchanged status eight were moderately improved and six re mained unchanged In eight of the 72 patients with no mitral insufficiency preoperatively slight mitral insufficiency resulted from mitral valvulotomy Five of these were markedly improved two moderately improved and one was moderately improved and then regressed to an unchanged status Seven of the 72 patients

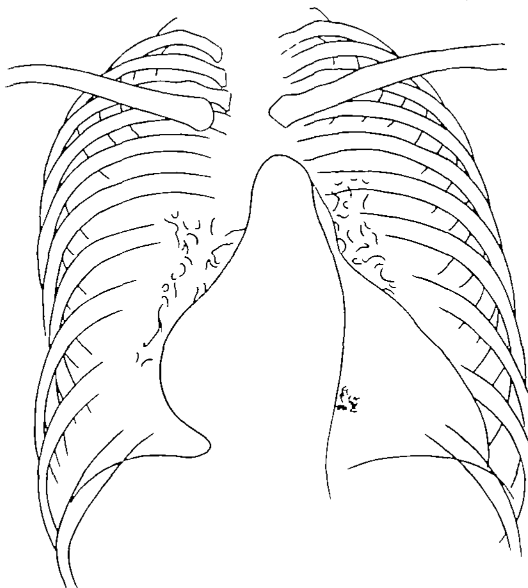


Figure 8 In this figure is shown a line drawing of Figure 7 The calcifica tion in the region of the mitral valve is represented by stippling

had moderate mitral insufficiency induced by valvulotomy Five were markedly improved and two were moderately improved by operation It appears that slight to moderate mitral insufficiency produced at operation does not preclude a good result in many cases Not a single patient who had no mitral insufficiency before valvulotomy was made worse by the operation, irrespective of the amount of mitral insufficiency which might result from valvulotomy

Of the 139 patients in the analysis, the surgeon was of the opinion that 53 had slight to moderate degree of mitral insufficiency before valvulotomy Of these 53 cases, 29 had the same degree of mitral insufficiency after the valvulotomy Of these 29 patients, 21 were markedly improved, three were moderately improved, three unchanged, one, at first, unchanged and then becoming worse and one worse at once Of these 53 cases, 16 had *slight* increase of the mitral insufficiency after operation Of these, nine were markedly improved, one markedly improved but regressed to the "unchanged" status, two moderately improved, two unchanged, and two worse Two patients had *moderate* increase of the degree of mitral insufficiency by operation In one of these the status was unchanged by operation, one patient improved and then became worse From these cases it seems that a *slight* increase in mitral insufficiency produced by operation does not preclude a good result, but neither of the two patients with a *moderate* increase of the pre-existing mitral insufficiency was improved

To continue the analysis of the effects of valvulotomy in these 53 patients with slight to moderate degrees of mitral insufficiency detected by the surgeon before valvulotomy, it was found that in one patient a regurgitant stream could not be palpated after operation This patient was markedly improved There was moderate decrease in the degree of mitral insufficiency in one patient The result in this instance was also one of marked improvement There was slight decrease in mitral insufficiency in four patients two were markedly improved, one moderately improved, and in one the status was unchanged Thus in six of the 67 (9 per cent) patients with slight, moderate or marked

mitral insufficiency mitral valvulotomy resulted in improvement of the pre-existing mitral insufficiency

The surgeon reported the detection of marked mitral insufficiency in 14 patients Ten of these had the same degree of mitral insufficiency after splitting of the valve Of these ten nine were markedly improved and one moderately improved Thus the presence of marked mitral insufficiency before valvulotomy does not preclude a good result In two of the fourteen patients with marked mitral insufficiency there was a slight increase in the regurgitation One of these patients was markedly improved and in one the status was unchanged In one patient marked mitral insufficiency before splitting was made significantly worse but despite this the patient was moderately improved by the procedure In the one patient in whom the marked mitral insuffi*ciency was slightly decreased by operation the patient s condition* became worse after operation

From another point of view in 35 patients mitral insufficiency was either created or made worse by operation Of these 35 20 were markedly improved six moderately improved four remained unchanged two were improved at first and then regressed to the unchanged status one improved at first but later became worse *and two* were worse after operation Accordingly 20 of 111 patients who were markedly improved (18 per cent) had mitral insufficiency created or made worse at operation

Six (25 per cent) of the 24 patients estimated as moderately improved (Section III p 90) four (18 per cent) of the 22 patients who remained unchanged by operation two (29 per cent) of seven patients who reverted to an unchanged state after initial improvement, *one patient who became worse after improvement* and finally two (50 per cent) of four patients made worse by operation all these listed in the groups above likewise had mitral insufficiency created or made worse by operation In short leaving the degree of mitral insufficiency as estimated at operation unchanged by valvulotomy or even if it is increased by valvulotomy does not prevent a good therapeutic result with benefit to the patient

In those patients who have mitral stenosis without insufficiency

in a deformed valve it is quite probable that the split will produce some degree of insufficiency. Moreover, in the group of patients who have moderate stenosis with some degree of regurgitation and who are not improved, the surgeon is working with a valve that is partially destroyed. There may be scarring that results in stenosis, but when a split is accomplished in these cases there is considerable likelihood that it will result in increase in insufficiency. If the stenosis has not reduced the valve size to a critical area, it is the insufficiency that is the most serious factor in its malfunction. Under these circumstances, an increase in the insufficiency will increase its malfunction and certainly the over-all status may be said to be worse. Many of these valves are calcified. This indicates destruction of the valve.

POSTOPERATIVE CARDIAC IRREGULARITIES

Fifty-four of the 200 patients (26.0 per cent) had significant arrhythmias in the immediate postoperative period. Many patients had rapid ventricular rates after the operation without change in rhythm. These are not included in the present analysis. Of the 200 patients, 105 had auricular fibrillation and 95 had normal rhythm. Forty-five of the 95 patients with normal rhythm (47.3 per cent) developed auricular fibrillation during the immediate postoperative course.* Thirty-nine of these 45 (86.7 per cent) reverted to normal rhythm before discharge from hospital. Of the 39 patients who reverted to normal rhythm, 26 received quinidine (66.8 per cent).

Thirteen of the 39 patients mentioned above who developed auricular fibrillation after operation reverted to normal rhythm while the use of digitalis was continued, often with the dosage increased, without the administration of quinidine. In many instances a fast-acting digitalis preparation was used to control the ventricular rate in auricular fibrillation.

The day of onset of the auricular fibrillation in the 39 patients who reverted to normal rhythm varied from the first to twenty-first postoperative day with an average of 4.9 days. Reversion to normal rhythm occurred between the third and thirty-first post-

* Auricular fibrillation did not occur while on the operating table.

operative day The average day of reversion was 12 8 days The average day after operation of onset of the auricular fibrillation in the six patients who did not revert to normal rhythm was also the fifth day with a range of 2 to 14 days Thus there is no difference in the time of onset in those who reverted to normal rhythm and those who did not

Five of the 39 patients with transient auricular fibrillation who reverted to normal rhythm had other arrhythmias These arrhythmias were auricular flutter with varying degrees of block and auricular paroxysmal tachycardia which occurred in varying sequential order with the auricular fibrillation before the rhythm was stabilized in normal mechanism

Six of the patients who developed auricular fibrillation left the hospital with this rhythm Quinidine was not used in two patients because of the history of emboli One patient was sensitive to the drug Auricular fibrillation in another patient did not revert to normal even though quinidine was used In two patients who left the hospital while auricular fibrillation was still present normal rhythm was restored one and two months postoperatively respectively One of these who reverted to normal rhythm after discharge was given gradually decreasing maintenance doses of quinidine When the drug was stopped three years after the operation auricular fibrillation again promptly recurred The drug was again effective however in restoring normal rhythm and the patient is still taking maintenance doses of quinidine

Quinidine was used in 26 of the 39 patients in whom the rhythm reverted from auricular fibrillation to normal rhythm The regimen used is discussed in Part I Section I p 15 The average postoperative day on which the auricular fibrillation occurred in these patients was the fifth (range one to 12 days) The average postoperative day on which quinidine was first used was the tenth (range 4 to 18 days) The average day of reversion was 11 5 (range 5 to 20 days) The average total amount of quinidine used was 1 8 gm (range 0 2 to 7 9 gm) and the average number of days the drug was used was 1 4 day (range 1 to 7 days)

Nine patients developed arrhythmias other than auricular

fibrillation after operation One of these had transient auricular paroxysmal tachycardia on the second postoperative day This was successfully treated with increased amounts of digitalis One patient in whom the rhythm was auricular fibrillation developed frequent ventricular premature contractions on the first postoperative day This was successfully treated with pronestyl In another patient who had auricular fibrillation at the time of operation normal rhythm with right bundle branch block superseded immediately after operation Ventricular paroxysmal tachycardia developed and the patient died twelve hours postoperatively Another patient developed sinus bradycardia with ventricular premature contractions giving rise to coupled rhythm on the first postoperative day This was successfully treated with pronestyl Another patient with normal rhythm developed complete heart block on the second day after operation and died on the third postoperative day In another patient, normal rhythm replaced auricular fibrillation on the day of admission to the hospital for a second mitral valvulotomy On the first postoperative day, auricular paroxysmal tachycardia with 2 1 block replaced normal rhythm On the following day the rhythm was auricular fibrillation Three days later auricular paroxysmal tachycardia with 2 1 block, later varying to 3 1 block, recurred On the tenth day after operation this rhythm was replaced by auricular fibrillation which persisted as the permanent rhythm The use of digitalis was continued as the only drug throughout these changing irregularities Another patient had one bout of auricular flutter with 2 1 block, reverting to auricular fibrillation and then again to auricular flutter with 2 1 block and then to complete heart block, and later still to auricular paroxysmal tachycardia between the third and twenty-third postoperative days These irregularities were thought to be due, in part to digitalis toxicity and the drug was discontinued The rhythm reverted to normal rhythm which persisted The use of digitalis was resumed

The one patient who had auricular flutter with block before operation went into auricular fibrillation on the first postoperative day and remained in this rhythm One patient with normal

rhythm had auricular premature contractions giving rise to coupled rhythm after operation Digitalis was discontinued and potassium chloride and quinidine were given with disappearance of the premature beats Digitalis was not required later

EFFECTS OF MITRAL VALVULOTOMY ON THE INCIDENCE OF PULMONARY EMBOLI

Twenty two patients had histories of pulmonary emboli before operation 12 exhibiting auricular fibrillation and 10 normal rhythm Six of those patients exhibiting auricular fibrillation and one exhibiting normal rhythm had thrombus material in the left auricle at the time of operation Of the 22 patients having had pulmonary emboli preoperatively only three (Case No 149 A L. N Y Hospital History No 692386 Case No 152 F C N Y Hospital History No 695331 Case No 190 H E N Y Hospital History No 707765) suffered from them after operation one at 22 months one at two months and the third patient sustaining two episodes one on the ninth postoperative day and the second six weeks after operation It appears that mitral valvulotomy has a favorable influence on the incidence of pulmonary emboli The first of the two patients with postoperative emboli exhibited normal rhythm the last auricular fibrillation Two of the three patients were treated with Dicoumarol

THE EFFECT OF MITRAL VALVULOTOMY ON THE INCIDENCE OF ARTERIAL EMBOLI

(With comments on (1) left auricular clots and arterial emboli before and after operation (2) multiple preoperative emboli (3) operative procedure when clots are found (4) use of Dicoumarol)

Forty five patients had a total of 62 systemic embolic episodes before mitral valvulotomy Included in this analysis are patients who had systemic emboli as presenting symptoms and also those patients who had emboli in the more distant past

Some of these episodes were not observed by us when they occurred In these cases the diagnosis was established by the history physical findings and reports of other physicians Of the 45 patients who had systemic emboli before operation 37

exhibited auricular fibrillation and eight normal rhythm The locations of the 62 arterial embolic episodes in these 45 patients are listed in Table 19 Over half of the emboli were cerebral

TABLE 19

LOCATION OF PREOPERATIVE ARTERIAL EMBOLI

Location	*Number of Patients*
Brain	32
Kidney	7
Spleen	4
Lower Extremity	13
Bifuration of the Abdominal Aorta	4
Eye	2
Total	62

Only one patient of the 45 who had arterial emboli before mitral valvulotomy had one afterward (Case No 212, E S, N Y Hospital History No 724289) In this patient exhibiting auricular fibrillation cerebral embolus occurred on the ninth postoperative day The patient made a good recovery Thrombus material was not detected in the left auricle at the time of operation She was treated, however, with anticoagulants Calcium had been liberated into the circulation during the valvulotomy, but no untoward effects were observed It appears that mitral valvulotomy decreases the incidence of arterial emboli in patients who had had them preoperatively

One patient in whom an organized thrombus was detected in the left auricle at the time of operation illustrates a special problem (Case No 300, J M, N Y Hospital History No 762318) Although the thrombus was not disturbed during operation, a new thrombus formed and caused the patient's death on the third postoperative day by occlusion of the mitral orifice The patient had not received heparin, but the administration of Dicoumarol had been begun on the first postoperative day

Of the 45 patients with preoperative arterial emboli, 16 (35 6 per cent) had, and 29 did not have, thrombotic material in the left auricle at the time of operation Of the 16 patients with thrombotic material 15 exhibited auricular fibrillation, and only one normal rhythm

From another point of view 30 patients had left auricular clots at operation Sixteen (53 3 per cent) had suffered preoperative arterial emboli but only two sustained arterial emboli at the time of operation and two others within the first postoperative month Twenty six of the 30 patients did not have arterial embolization during or after operation Accordingly 16 patients (53 3 per cent) with left auricular clots had preoperative emboli but only four of the 30 (13 4 per cent) had them during or after operation It appears that 24 patients (86 6 per cent) with left auricular clots at operation had no arterial emboli during or after operation

Thirteen of the 45 patients had suffered multiple preoperative arterial embolic episodes varying from two to four in number and occurring in many areas There were 30 separate embolic episodes 16 being to the brain All but two of the 13 patients exhibited auricular fibrillation Four of the 13 patients (30 7 per cent) had thrombotic material in the left auricle This is approximately the same percentage as was found in those patients with single embolic episodes

In one patient the surgeon thought a clot was liberated into the circulation (Case No 157 O R N Y Hospital History No 699084) and in another (Case No 212 E.S N Y Hospital History No 724289) a piece of calcium entered the circulation during the valvulotomy In neither case was there any untoward effects

If clot formation is suspected in the auricle or auricular appen dage during the operative procedure either because of a history of previous emboli or of changes present in the auricular appen dage wall by inspection and palpation occlusion of the carotids is instituted before the clots are disturbed If clots are present in the atrium they are removed If they are in the auricle itself they are not disturbed if the stenosed mitral valve can be examined and opened without fragmenting the thrombus

Usually the intra-auricular thrombus extends from the appen dage orifice posteriorly and medially and may occupy the wall of the auricle between the pulmonary vein and the mitral valve If a clot is fragmented and incompletely removed, there is a tendency for new clot to form upon the surface thus exposed

and then to propagate through the mitral orifice If the thrombus is not large and can be left undisturbed after enlarging the mitral orifice, anticoagulant therapy is instituted. This seems, at present, to be the safest procedure If it were the opinion that fragments of clot or calcium had been liberated into the circulation, the use of anticoagulants was instituted immediately after operation

Of the 45 patients with preoperative systemic emboli, 22 had no anticoagulant therapy at any time Eight patients were on Dicoumarol preoperatively, but use of the drug was not reinstituted after operation In six patients Dicoumarol was discontinued preoperatively and its use resumed after operation In nine patients Dicoumarol was administered only after operation

Of the 22 patients who had systemic emboli but had never received anticoagulant therapy, eight had auricular thrombi and fourteen did not None of the eight patients who were receiving Dicoumarol preoperatively, but the drug was not used after operation, had thrombi at the time of operation Two of the six patients who were receiving Dicoumarol before operation and in whom its use was resumed after operation had thrombi at operation, as did also five of the nine patients who were given the drug postoperatively for the first time

EMBOLIC PHENOMENA POSTOPERATIVELY IN PATIENTS WHO HAD NOT SUFFERED EMBOLI BEFORE OPERATION

Incidence of Postoperative Pulmonary Emboli in Patients who had no Pulmonary Emboli before Operation

Five patients who did not have pulmonary emboli before the operation had such episodes afterward

Case No 125, P M, N Y Hospital History No 588591
Case No 133 M M, N Y Hospital History No 671615
Case No 245 R R, N Y Hospital History No 235852
Case No 252, H S, N Y Hospital History No 738935
Case No 271 L H N Y Hospital History No 752526

Two of these five patients (Case No 125, Case No 252 and, possibly, Case No 245) had pulmonary emboli during the first month after the operation, and the other three suffered this complication after the first month One of the patients had two pulmonary emboli (Case No 274) one at two months, the other

at five months after operation All of the patients exhibited auricular fibrillation at the time of embolization Only one of the patients had thrombotic material in the left auricle at the time of operation (Case No 274) In another the presence of thrombi could not be ascertained because the left auricle was densely calcified (Case No 133) Three of the five patients were treated with Dicoumarol (Case No 133 Case No 245 Case No 274)

Incidence of Postoperative Arterial Emboli in Patients who had no Arterial Emboli before Operation

Eight patients who did not give histories of preoperative arterial emboli had arterial emboli during or after operation Of these eight patients five (Case Nos 105 159 165 252 297) had emboli at operation one of these suffered a saddle embolus and died shortly after operation (Case No 159) Another patient (Case No 252) was found to have a hemiparesis when she reacted from the anaesthetic. It was thought that a piece of calcium liberated into the circulation during valvulotomy had entered the cerebral circulation One had an embolus to the left eye nine days postoperatively (Case No 299) Two patients had emboli after the first postoperative month (Case Nos 149 and 165) Both of these accidents were located in the cerebrum the first occurring at two months and the other at 25 months Both patients made good recoveries Five of the eight patients exhibited auricular fibrillation and three normal rhythm Four of the eight patients had thrombi in the left auricle at operation

Two of the five patients who had arterial emboli at operation had thrombus material in the left auricle The one patient who suffered an embolus within the first month had thrombus material at the time of operation and one of the two patients who had emboli after the first month had thrombus material at the time of operation In short four of the eight patients in this category had left auricular clots

Three of the eight patients were treated with anticoagulants one died shortly after operation Four patients were not given anticoagulants after discharge usually because of unreliability of these patients in carrying out directions

Incidence of Postoperative Pulmonary and Arterial Emboli in Patients who had not Suffered these Accidents Preoperatively

There were eight patients in this category, some of whom are included in the two analyses above Six exhibited auricular fibrillation and two normal rhythm Two had thrombus material in the left auricle at the time of operation One patient (Case No 297) had a single arterial embolus (left leg) six hours postoperatively, two patients (Case Nos 105, 165) had two arterial emboli (cerebral and right leg at operation, cerebral at operation and another cerebral at two months), two patients had one arterial and one or more pulmonary emboli (cerebral at operation, pulmonary at seven days (Case No 252), and left eye and multiple pulmonary at nine days (Case No 299)), one patient had a single pulmonary embolus nine months after operation (Case No 245) This patient may have had a pulmonary embolus on the second postoperative day Two patients had two pulmonary emboli One (Case No 125) had bilateral emboli at two months after operation (this one is questionable), and the other had two pulmonary emboli at two months after operation (Case No. 133). The patient with the cerebral and right leg emboli at operation and the one with multiple pulmonary emboli and the arterial emboli to the left eye nine days postoperatively alone had thrombus material in the left auricle at operation

THE INCIDENCE OF LEFT AURICULAR THROMBI AT OPERATION AND POSTOPERATIVE EMBOLIC PHENOMENA

This discussion is about the 30 patients (16 per cent) of 188 in the analysis who had left auricular thrombi at operation Twenty-one of these (70 0 per cent) had neither arterial nor pulmonary emboli either at the operation nor during the follow-up period Two had emboli at operation (cerebral, right leg in one (Case No 105) a saddle embolus in the other (Case No 159)) This last patient died 3 hours postoperatively One patient died on the table in cardiac arrest occurring after evacuation of thrombus material from the left auricle (Case No 112) An autopsy not being permitted, it cannot be decided whether systemic

embolization had occurred One patient (Case No 231) had a large amount of thrombus material in the left auricle It was partially evacuated Heparin was administered immediately after operation and was continued until the patient's death Hypotension occurred six hours postoperatively and the patient died on the tenth postoperative day after a stormy course Among the autopsy findings were multiple hemorrhages into the skin and subcutaneous tissues of the chest wall and into the pleural cavity stomach and left lung *

Two patients had emboli during the first postoperative month one had multiple pulmonary emboli and an embolus probably to the left eye (Case No 299) the other patient (Case No 300) suffered a left auricular thrombus which occluded the mitral orifice on the third postoperative day

One patient (Case No 274) had pulmonary emboli during the follow up period and another (Case No 262) had multiple cerebral emboli during this period

In one patient (Case No 101) the left auricle could not be entered because of a large left auricular clot

It is concluded that most patients with left auricular thrombi do not have postoperative emboli

The autopsy specimens of a patient in whom a left auricular thrombus developed in the two week period between the second valvulotomy and his death are shown in Figures 2 3 4 and 5 Thrombus material was not found in the left auricle at the time of the first operation At the second operation an organized clot was found in the stump of the left auricular appendage The patient never had thrombo-embolic phenomena and no emboli were found at necropsy

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Another patient having a left auricular thrombus at operation (Case No 157) (who had two pulmonary and one cerebral embolus preoperatively) suffered severe vertigo two months postoperatively Dicoumarol had been given following operation because of the left auricular clot, and it was thought that labyrinthine hemorrhage caused this episode Dicoumarol was discontinued.

PATIENTS WITH THROMBI IN THE LEFT AURICLE AT OPERATION WITHOUT HISTORIES OF EMBOLI PREOPERATIVELY WHO DID NOT HAVE EMBOLI AT ANY TIME AFTER OPERATION

Seven of the 30 patients with thrombus material in the left auricle at the time of operation, all exhibiting auricular fibrillation, had no evidence of emboli before operation, at operation, or after operation (Case Nos 123, 129, 158, 220, 267, 275, 284)

Thus patients may have thrombus material in the left auricle at the time of operation and yet sustain no embolization afterward

In three of these seven patients, the clots were not disturbed (Case Nos 123, 220, 284) and in four the thrombus material was evacuated The largest clot which was removed measured 6 by 5 by 3 cm (Case No 129)

DURATION OF POSTOPERATIVE FEVER

Duration of fever after operation was analyzed in 185 patients Six patients did not have fever postoperatively The average duration of fever after operation was 10 days, with 56 days being the maximal duration

TIME OF MAXIMAL IMPROVEMENT AFTER THE OPERATION

The time after operation at which maximal improvement occurred was analyzed in 116 patients. This time varied from immediately postoperatively to as long as 15 months The average was 2 1 months after operation

FATE AFTER OPERATION OF THE PREOPERATIVE MURMUR THOUGHT TO BE DUE TO AORTIC INSUFFICIENCY

Twenty-three patients had murmurs preoperatively which were thought to be due to aortic insufficiency In 13 patients the murmurs persisted postoperatively Ten of these 13 patients were markedly and three moderately improved by operation In 10 patients the murmur was not audible after operation Seven of these 10 were markedly improved, one was markedly improved

and then regressed to an unchanged status one was unchanged and one was worse after being at first unchanged It appears that whether the murmur of aortic insufficiency disappeared or remained unchanged after operation does not materially effect the degree of improvement.

Four patients before the operation had murmurs thought to represent pulmonic insufficiency Only one was audible postoperatively Three patients in whom the murmur was not audible after operation were markedly improved The status of one patient in whom the murmur persisted was unchanged by operation

Seven patients had murmurs thought to be aortic insufficiency after operation but these murmurs had not been present preoperatively Five were markedly and two moderately improved One of these seven patients was thought to have had acute rheumatic fever six weeks after operation In another patient the murmur was first heard two weeks postoperatively and was also considered as possibly related to an attack of acute rheumatic fever In the other five patients the murmurs were heard for the first time when the patients were seen in follow up after operation

POSTOPERATIVE COMPLICATIONS

The following are the major complications which occurred during the postoperative period

Complication	Number	
Chest pain, fever ("Post Valvulotomy Syndrome")	28	
Acute rheumatic fever	4	(with 1 more possible)
Arterial emboli	2	(with 1 more possible)
Pulmonary emboli	3	(with 1 more possible)
Pneumonitis (of major proportions)	10	(with 3 more possible)
Atelectasis of lung (of major proportions)	1	(with 1 more possible)
Moderate or high fever without definite diagnosis of cause	5	
Thrombophlebitis	8	
Pleural effusion (of major proportions)	11	
Low salt syndrome	1	(this occurred in 2 additional patients who died in the postoperative period)

Part I Section III p 4 and Part II, Section III p 124

Pleural friction rub	8	(with 1 more possible)
Pericardial friction rub	20	(with 2 more possible)
Obstructing tracheobronchial secretions requiring tracheostomy	2	
Asthma or bronchospasm	3	
Pericardial effusion (or cardiac dilatation)	2	(with 2 more possible)
Pulmonary edema	2	
Postoperative irregularities of the heart rhythm	54	
Psychiatric complications	11	
Cholecystitis	7†	
Penicillin reaction	2	(with 1 more possible)
Gangrene due to arterial embolus requiring amputation of leg	1	

One patient (Case No 165, M M , N Y Hospital History No 694202) a 42 year old woman, had an unusual postoperative course Cardiac standstill occurring during operation was treated by cardiac massage and the heart beat was restored. Tracheotomy was required The patient was not responsive for two days, but recovered with a left hemiparesis Azotemia developed and increased for the first postoperative month, although urinary output remained high Urinary infection and pneumonia were complications There was moderate fever for 21 days after operation When the patient was seen in follow up one year five months after the operation, it was our opinion that the patient had been markedly improved by operation

It was our impression that psychiatric complications in this series were no more frequent than following operations of similar magnitude in other parts of the body

INCIDENCE OF ASCHOFF BODIES IN THE LEFT AURICLE AND ITS RELATIONSHIP TO THE AGE OF THE PATIENT

From inspection of Table 20, it is seen that younger patients have a greater chance of having Aschoff bodies in the left auricle than older patients, but this manifestation occurs in all age groups Fifty-seven (29 8 per cent) of the 191 patients in the analysis had Aschoff bodies

† Two emergency cholecystectomies were performed one three days and the other three weeks postoperatively

TABLE 20

AGE DISTRIBUTION AND ASCHOFF BODIES

Age Distribution of 191 Cases Analyzed for Aschoff Bodies in Auricular Appendages Resected at Operation

Age years	*Aschoff Present*	*No Aschoff*
10-20	2	1
21 30	18	13
31-40	22	45
40-50	9	55
> 50	6	20
Total	57	134

THROMBI IN THE LEFT AURICLE AT OPERATION IN RELATION TO ASCHOFF BODIES

Of the 183 patients in the analysis 80 3 per cent had no thrombi and 19 7 per cent had thrombi in the left auricles at the time of operation Of patients with Aschoff bodies 89 1 per cent had no thrombi and 10 9 per cent had thrombi Of patients without Aschoff bodies 76 6 per cent had no thrombi 23 7 per cent had thrombi It appears that thrombi were more than twice as common in patients without Aschoff bodies as in patients with Aschoff bodies. Patients who had thrombi detected at operation thirty (83 3 per cent) of 36 did not have Aschoff bodies

ASCHOFF BODIES IN RELATION TO RHYTHM

Of 191 patients in the analysis 52 per cent exhibited auricular fibrillation and 48 per cent normal sinus rhythm

With respect to patients who had Aschoff bodies in their auricular appendages a higher percentage exhibited normal rhythm (73 6 per cent) than auricular fibrillation (26 4 per cent) On the other hand with respect to patients who did not have Aschoff bodies in their auricular appendages a higher percentage exhibited auricular fibrillation (62 7 per cent) than normal rhythm (37 3 per cent)

Of the 99 patients in whom the rhythm was auricular fibrillation, 15 (15.2 per cent) had Aschoff bodies in the auricular appendages. Of the 92, however, exhibiting normal rhythm 42 (45.7 per cent) had Aschoff bodies. It appears that Aschoff bodies occur three times more frequently in the presence of normal rhythm than when auricular fibrillation prevails. It is known that auricular fibrillation is a relatively late occurrence in the natural history of rheumatic heart disease. In an earlier section, page 122, it was pointed out Aschoff bodies occur more frequently in younger individuals than in older ones. It appears that Aschoff bodies occur more frequently in younger individuals and in those with normal sinus rhythm, this rhythm also being more frequently encountered in the younger rheumatic age group than is auricular fibrillation.

CHEST PAIN AND ACUTE RHEUMATIC FEVER AFTER MITRAL VALVULOTOMY

The majority of patients had incisional chest pain after operation. This type of pain usually disappeared within several days or weeks, although in a few patients it persisted longer. Many of the patients with pulmonary infarction and many of those with pneumonia also had chest pain. These patients are not discussed in this section.

The majority of patients had a small effusion in the left pleural cavity. Certain patients had increase in cardiac size in x-ray photographs of the chest after the operation. Many had pericardial friction rubs. The incidence of these signs is probably related to the intensity of the search for them. For example, an unsuspected cardiac dilatation or pericardial effusion was at times first revealed in a routine postoperative x-ray photograph of the chest.

Twenty-eight of the 170 patients in this analysis had signs and symptoms suggestive of the symptom-complex that has been come to be known as "The Postvalvulotomy Syndrome." Fever, chest pain, often pleuritic in nature, pericardial and/or pleural friction rubs, pericardial and/or pleural effusions, leukocytosis, elevated sedimentation rates, and positive C-reactive protein tests

were present in varying frequency The onset of this set of symptoms in this series varied from almost immediately postoperatively to four months after operation The course often was cyclic In addition two patients who had *cardiotomy without operation on the mitral valve* were also thought to have The Post Valvulotmy Syndrome

A recent analysis of patients with chest pain after cardiac surgery at The New York Hospital-Cornell Medical Center has suggested the non rheumatic basis of The Postvalvulotomy Syndrome This syndrome occurred in 13 or 24 pericardiotomies performed for congenital malformations of the heart and great vessels in patients who did not have rheumatic heart disease This occurrence rate corresponds to the highest incidence reported after mitral valvulotomy The only common factor in these 13 cases was a wide pericardial incision In contrast the characteristic chest pain did not occur in two patients in whom only a small segment of pericardium was clamped during the excision of a pericardial cyst. From the analysis mentioned above it was suggested that Postpericardiotomy Syndrome* was a more appropriate designation than Postvalvulotomy Syndrome for this complication Traumatic pericarditis possibly with intrapericardial bleeding was suggested as the probable cause of this symptom complex

Seven patients complained of chest pain with exertion Patients having this association of pain before operation might be relieved of it by operation In most patients this type of pain was thought not to be angina due to arteriosclerotic heart disease but related to mitral stenosis

Twenty three patients had chest pain that did not fall into either of the two categories discussed above that is to say not postvalvulotomy and not associated with exertion

In the over all analysis 70 of 170 patients had significant chest pain

Activation of acute rheumatic fever was thought to have occurred after operation in four patients and possibly in still another patient All the patients were women Even though these

* T Ito M A Engle and H P Goldberg

patients suffered attacks of acute rheumatic fever postoperatively, two were markedly and three moderately improved. Two of the five patients were pregnant. Case No. 140 (B.H., N.Y. Hospital History No. 687528) suffered arthralgia with a rise in antistreptolysin titer (75 to 600 units) and an elevated sedimentation rate, two years and seven months postoperatively. The throat culture was negative at this time. She was not on prophylactic penicillin at the time. Nevertheless, the patient has been moderately improved by operation.

Case No. 195 (M.K., N.Y. Hospital History No. 589823) was subjected to mitral valvulotomy at the time she was six months pregnant. The postoperative course was complicated by the "Post-valvulotomy Syndrome" and supraventricular arrhythmias. Four weeks after operation a 290 gm. stillborn fetus was delivered. Six weeks postoperatively acute pulmonary edema, arthralgia, fever, a new basal diastolic murmur, elevated white count, a four plus C-reactive protein test, and increased P-R conduction time in the electrocardiogram led to the diagnosis of acute rheumatic fever. There was good response to the use of salicylates. When the result of operation was evaluated one year and two months after operation, the basal diastolic murmur was still audible, but it was the consensus that the patient was markedly improved.

Case No. 208 (J.P., N.Y. Hospital History No. 717081) who had a mitral valvulotomy in the fourth month of pregnancy suffered fever, severe pleuritic chest pain and paroxysmal auricular fibrillation in the immediate postoperative period. A new basal diastolic murmur was first heard two weeks after operation. She went on to deliver a full-term infant. When the result of operation was evaluated one year and three months postoperatively, she was considered moderately improved as compared to her status before pregnancy. This patient also has tricuspid stenosis.

Case No. 213 (M.W., N.Y. Hospital History No. 721677) was suspected of having acute rheumatic fever shortly after mitral valvulotomy because of the occurrence of fever, chest pain, and a pericardial friction rub. The patient improved on the use of salicylates. The patient was markedly improved when seen eleven months after operation.

Case No 269 (M B N Y Hospital History No 689241) ran a prolonged fever after mitral valvulotomy The C-reactive protein test and sedimentation rates were elevated The fever gradually subsided It was not possible to be certain that this episode represented an attack of acute rheumatic fever It was difficult to evaluate the result in this patient but she was thought to be moderately improved at the time of follow up (5 months)

RESULTS OF MITRAL VALVULOTOMY IN PATIENTS OVER 55 YEARS OF AGE

Twelve patients were 55 years of age or older when mitral valvulotomy was performed The average age was 57 years The oldest patient Case No 289 (J C N Y Hospital History No 738903) 63 years of age was subjected to mitral valvulotomy because of recurrent attacks of pulmonary edema. A good split was obtained and the patient has not had a single attack of pulmonary edema during the eight months follow up At operation the surgeon found the coronary arteries of this patient to be markedly sclerotic The result of operation in this patient was dramatic Of the 12 patients over 55 years of age five were markedly improved four remained unchanged one reverted to an unchanged status after an initial improvement, and two were worse right after operation Thus postoperatively a higher percentage of patients in this age group were unchanged or worse as compared to the over all results in the whole series Nevertheless 41 6 per cent were markedly improved. There was a high incidence of concomitant serious disease One patient Case No 286 (H C N Y Hospital History No 748357) who became worse after operation experienced attacks of severe chest pain preoperatively which were thought to be related to coronary insufficiency Chest pain improved after operation but heart failure was much worse Another patient Case No 155 (R K N Y Hospital History No 644766) had arteriosclerotic heart disease with left bundle branch block and cancer of the ovary Her condition was unchanged by mitral valvulotomy Four patients had experienced cerebrovascular accidents before operation Of these four patients three were markedly improved and one was unchanged by mitral

TABLE 21

Valvulotomy Performed During Pregnancy in Second and Third Hundred Patients

Case No Hospital History No	Age	Month of Pregnancy	Previous Pregnancies	Reason for Operation	Murmurs	Operative Split	Complications of Operation	Delivery	Complications of Delivery	Condition of Infant	Months Follow up	Status at Follow up	Comments
Case No 120 S 7057	27	3½	1	Progressive dyspnea during this and the first pregnancy	M S M I A I	Good	None	Premature delivery (fetus weighed 1930 gm)	A F† during first stage of labor*	Good	35	2+ improvement A F continues	
Case No 121 W 3260	39	5	1	Progressive dyspnea	M S A I	Good	None	Caesarean section at full term because of fetal distress	None	Good	34	2+ improvement A I not heard	
Case No 127 R 79355	26	1	1	Progressive dyspnea during this and previous pregnancy	M S M I A I	Good	None	Normal full term delivery	None	Good	30	2+ improvement	
Case No 136 T 70787	36	5	1	Progressive dyspnea	M S, A I	Good	None	Normal full term delivery	None	Good	31	2+ improvement	
Case No 147 P 55711	31	5	1	Dyspnea pulmonary edema	M S	Good	Cessation of heart beat for a few seconds	Full term delivery, low forceps	None	Good	11	2+ improvement	
Case No 151 L M 10000	30	6	1	Progressive dyspnea	M S M I	Good	None	Normal full term delivery	None	Good	24	2+ improvement	

† A F = auricular fibrillation

*Patient refused to prolong hospitalization to attempt reconversion another pregnancy resulted in premature spontaneous delivery (1820 gm) stillborn

TABLE 21—continued

Valvulotomy Performed During Pregnancy in Second and Third Hundred Patients

Age	Month of Pregnancy	Previous Pregnancies	Reason for Operation	Murmurs	Operation Split	Complications of Operation	Delivery	Complications of Delivery	Condition of Infant	Months Follow-up	Status at Follow-up	Comments
25	6	1	Progressive dyspnea and fatigue during this and previous pregnancy	M S.	Good	None	Normal full term delivery	None	Good	21	2+ improvement	
27	6	2	Progressive dyspnea, hemoptysis	M.S. M.I.	Good	None	Spontaneous premature delivery (4 weeks post operative) (?90 gm.)	None	Died	14	1+ improvement	Acute R. F 6 weeks post valvulotomy
19	4	1	Progressive dyspnea, during this and the first pregnancy	M S M I	Poor	None M I predominant lesion	Normal full term delivery	None	Good	13	Unchanged	Cholecystectomy since valvulotomy
30	4	1	Progressive dyspnea, hemoptysis	M S T I	Good	None	Normal full term delivery	None	Good	15	1+ improvement	Probable acute R. F in immediate postoperative period.
28	2 4	1	Progressive dyspnea during this and the previous pregnancy	M S M.I ? P L	Good	None	Normal full term delivery	None	Good	10	2+ improvement	
35	4	4	Dyspnea during pregnancies	M.S T I	Good	None	Normal full term delivery	None	Good	2	1+ improvement	

eumatic fever

valvulotomy One patient, Case No 186 (M H, N Y Hospital History No 708718) had lupus erythematous which was quiescent at the time of mitral valvulotomy This patient reverted to an unchanged status after initial improvement. Another, Case No 278 (E C, N Y Hospital History No 738565) had had a meningioma removed five and a half months before mitral valvulotomy Diabetes mellitus, a non-functioning right kidney and bilirubinemia were complicating problems This patient was not improved by operation * Only three patients had no concomitant serious disease

MITRAL VALVULOTOMY IN PREGNANCY

Twelve patients had mitral valvulotomy during pregnancy (Table 21) The time during pregnancy at which operation was performed varied from two and three-quarters to six months Nine patients after operation had normal deliveries at term, one required a Caesarean section because of fetal distress, and two patients delivered prematurely In the case of one of the latter patients, the fetus died It is our opinion that mitral valvulotomy was of benefit to 10 of 12 patients who otherwise would have had serious difficulty during pregnancy The over-all evaluation of the results of operation attempted to assess the patient's status after delivery, as compared to her status before she became pregnant One patient (Case No 198) at operation was found to have predominant mitral insufficiency and only moderate stenosis, which was not altered appreciably by operation When severe and progressive symptoms from mitral stenosis have developed during pregnancy, it is our opinion that mitral valvulotomy allows pregnancy to continue with safety to normal delivery, when serious difficulty might otherwise have been expected Improvement experienced by these patients after the delivery allows them to take more adequate care of the baby

Two of the twelve patients had acute rheumatic fever postoperatively (Case No 195 and Case No 208) Both patients delivered normal babies and were thought to have been improved by operation when they were seen in follow up

* This patient died after the analysis in this series was closed Her course is detailed in Part III, Section I (also note Figure 21)

SECOND OPERATIONS FOR MITRAL STENOSIS

Five patients had two operations on the mitral valve (Table 22) In three of these the first operation was performed and reported in the first one hundred mitral valvulotomies (Part I) One patient had both operations in the present series now being discussed One patient s first mitral valvulotomy was performed at another hospital The patients will be mentioned briefly

Case No 161 (A S N Y Hospital History No 19180) a 47 year old woman had mitral stenosis and mitral insufficiency Mitral valvulotomy was undertaken because of exertional dyspnea and pulmonary emboli A technically successful mitral valvulotomy was performed in April 1953 Postoperative improvement was marked for the first six months Because of congestive failure a second mitral valvulotomy was performed 21 months after the first one The surgeon found further distortion of the mitral valve but did not think that refusion of the leaflets had occurred The operative split on this occasion was not satisfactory The patient was listed as improved At each operation slight mitral insufficiency was thought by the surgeon to be present and it was increased slightly by the second operation On the positive side however of effect of operation there have been no further pul monary emboli since the first operation

Case No 265 (L.K N Y Hospital History No 602960) a 38 year old man was accepted for mitral valvulotomy because of exertional dyspnea congestive heart failure and a probable old renal embolus The blood urea nitrogen was elevated and it was thought the patient had chronic nephritis. The murmurs of mitral stenosis and mitral insufficiency were heard The x ray photograph of the chest showed marked calcification in the region of the mitral valve (Figs 7 and 8) A technically satisfactory split of the *lateral* commissure of the mitral valve was obtained in July 1951 After operation improvement was modest. Gradually heart failure recurred Five years and three months after the first mitral valvulotomy the mitral valve was explored again On this occasion a fairly good split was obtained at the *medial* com missure The surgeon thought that the basic rheumatic process had progressed since the first operation with additional calcium

TABLE 22

Operations for Mitral Stenosis

First Operation

Case No N Y Hospital History No	*Age Sex*	*Reason for Operation*	*Preoperative Valvular Diagnoses*	*Date of 1st Operation Mo Yr*	*Size of Valve Before Operation*	*Size of Valve After Operation*	*Adequacy of Split*	*Valve Calcification**	*Comments on Operation*	*Postoperative Course*
Case No 67 A S 19180	17 female	Progressive dyspnea	M S M I	5/53	1 by 0 25 cm	3 to 4 cm²	Good	+	Very slight M I	Good improvement for 5 months then went into heart failure
Case No 5 L K 402960	38 male	Progressive dyspnea	M S M I	7/51	2 to 3 mm by less than 1 cm	Greatest diameter over 2 cm	Good	+ •	Good split only laterally	Only moderately improved Deteriorated after 4 years
Case No 32 C B 372986	41 female	Progressive dyspnea	M S M I A S A I	9/52	less than 1 cm²	Markedly enlarged	Good	+	Very satisfactory result. A little M I	Patient claimed no improvement Limitation became progressively worse
Case No 143 I G 661758	29 male	Progressive dyspnea	M S M I	9/54	less than 1 5 cm²	4 cm²	Good	+	Very satisfactory result Some M I	8 months improvement then regressed to preoperative status
Operated elsewhere Case No 292 G A 710559	33 female	Progressive dyspnea	M S other diagnoses not known operation elsewhere	4/54	?	?	Poor	?		Improved for 6 months Regressed during pregnancy

*Calcification 0 — none
± — moderate
+ — marked
• — see Figures 7 and 8

TABLE 22 (*continued*)

OPERATIONS FOR MITRAL STENOSIS

Second Operation

Case No. N Y Hospital History N	*Pre-operative Valvular Diagnoses*	*Date of 2nd Operation Mo. Y*	*Number of 2nd Operation*	*Time Between Operations*	*Size of Valve Before Operation*	*Size of Valve After Operation*	*Adequacy of Split*	*Valve Calcification*	*Comments on Valve as Found at Operation*	*Post-operative Course*	*No of Months Follow-up Since 2nd Operation*
Case No 67 A S 19180	M S	2/55	161	1 year 9 months	1 5 to 2 cm²	2 5 to 3 cm²	Poor	⊕	Further distortion of valve not resealing Slight increase in M I created by operative split	Unchanged	20
Case No 3 L K 602960	M S M I ?T S	10/56	265	3 years, 3 months	slightly over 1 cm²	2.5 to 3 cm²	Fairly Good	+	Further involvement of valve with fusion and calcium deposition. Moderate M I unchanged.	Moderately improved	3½
Case No 32 C B 372986	M S M I A L T L	10/56	271	4 years, 1 month	1 2 cm²	3 5 cm²	Good	⊕	No valve motion. Very distorted and scarred valve. Evidence of myocarditis. M I not increased	Markedly improved	6
Case N 143 J G 661738	M S M I T I	6/56	256	1 year 9 months	less than 2 cm²	2.5 to 3 cm²	Fairly Good	⊕	Lateral commissure had refused. M I not increased.	Markedly improved	5
Operated elsewhere Case No 292 G A 710689	M. S M I T I	2/57	292	2 years, 10 mos.	0 5 cm²	2 5 to 3 cm²	Good	+	Good split only medially Calcium laterally A few chordae split M I not increased	Markedly improved (short follow-up)	2

Calcification 0 — none
+ — moderate
⊕ — marked
† — see Figures 7 and 8

TABLE 22

OPERATIONS FOR MITRAL STENOSIS

First Operation

Case No. N. Y. Hospital History No.	Age Sex	Reason for Operation	Preoperative Valvular Diagnoses	Date of 1st Operation Mo. Yr.	Size of Valve Before Operation	Size of Valve After Operation	Adequacy of Split	Valve Calcification*	Comments on Operation	Postoperative Course
Case No. 67 A. S. [illegible]	17 female	Progressive dyspnea	M. S. M. I.	5/53	1 by 0.25 cm.	3 to 4 cm.²	Good	+	Very slight M. I.	Good improvement for 5 months, then went into heart failure
Case No. 3 L. K. [illegible]	38 male	Progressive dyspnea	M. S. M. I.	7/51	2 to 3 mm. by less than 1 cm.	Greatest diameter over 2 cm.	Good	+ •	Good split only laterally	Only moderately improved. Deteriorated after 4 years
Case No. 32 C. B. [illegible]	41 female	Progressive dyspnea	M. S. M. I. A. S. A. I.	9/52	less than 1 cm.²	Markedly enlarged	Good	+	Very satisfactory result. A little M. I.	Patient claimed no improvement. Limitation became progressively worse
Case No. 113 I. G. [illegible]	29 male	Progressive dyspnea	M. S. M. I.	9/51	less than 1.5 cm.²	4 cm.²	Good	+	Very satisfactory result. Some M. I.	8 months improvement then regressed to preoperative status
Operated elsewhere Case No. 292 G. A. [illegible]	33 female	Progressive dyspnea	M. S. other diagnoses not known operation elsewhere	1/51	?	?	Poor	?		Improved for 6 months. Regressed during pregnancy

*Calcification: 0 — none
+ — moderate
++ — marked
• — see Figures 7 and 8

TABLE 22 *(continued)*

Operations for Mitral Stenosis

Second Operation

Case No. N.Y. Hospital History No.	*Pre-operative Valvular Diagnosis*	*Date of 2nd Operation N.Y.*	*Number of 2nd Operation*	*Time Between Operations*	*Size of Valve Before Operation*	*Size of Valve After Operation*	*Adequacy of Split*	*Valve Calcification*	*Comment on Valve as Found at Operation*	*Post-operative Course*	*No. of Months Follow-up Since 2nd Operation*
Case No 67 A. S. 19180	M. S	2/55	161	1 year 9 months	1 5 to 2 cm^2	2 5 to 3 cm^2	Poor	⊕	Further distortion of valve not resealing. Slight increase in M.I. created by operative split.	Unchanged	20
Case No 3 L K 602960	M S. M I PT S	10/56	265	5 years, 3 months	slightly over 1 cm^2	2.5 to 3 cm^2	Fairly Good	+	Further involvement of valve with fixation and calcium deposition. Moderate M.I. unchanged.	Moderately improved	3½
Case No 32 C B 372986	M S M I A I T I	10/56	271	4 years, 1 month	1 cm^2	3 5 cm^2	Good	⊕	No valve motion Very distorted and scarred valve. Evidence of myocarditis. M.I. not increased	Markedly improved	6
Case No 143 J G 661738	M S M I T L	6/56	256	1 year 9 months	less than 2 cm^2	2 5 to 3 cm^2	Fairly Good	⊕	Lateral commissure had refused. M I not increased.	Markedly improved	5
Operated elsewhere Case N 292 G A 710689	M S M I T I	2/57	292	2 years, 10 mos.	0 5 cm^2	2.5 to 3 cm^2	Good	+	Good split only medially Calcium laterally A few chordae split. M I not increased	Markedly improved (short follow-up)	2

Calcification 0 — none
\+ — moderate
⊕ — marked
* — see Figures 7 and 8

deposition and fixation of the valve There has been moderate improvement after the second operation

Case No 271 (C.B , N Y Hospital History No 372986), a 41 year old woman was considered for mitral valvulotomy because of exertional dyspnea, orthopnea, evidence of congestive heart failure and an old renal embolus The murmurs of mitral stenosis mitral insufficiency, aortic stenosis and aortic insufficiency were heard, but mitral stenosis was thought to be the predominant lesion A technically successful mitral valvulotomy was performed in September 1952. The patient did not appear to have any improvement Gradually she became more incapacitated In October 1956, four years and one month after the first operation, the mitral valve was explored again The valve was found to be markedly scarred and distorted, but a good split was obtained The slight amount of mitral insufficiency found at both operations was not increased on either occasion The patient has been markedly improved since the second operation

Case No 256 (J G , N Y Hospital History No 661738) a 29 year old man, was accepted for mitral valvulotomy in September 1954 because of exertional dyspnea and fatigue, occasional paroxysmal nocturnal dyspnea, and other evidences of congestive heart failure The murmurs of mitral stenosis and mitral insufficiency were heard At operation an excellent split was obtained There was a moderate amount of mitral insufficiency The patient was improved for eight months, and then regressed to his preoperative status The murmurs of mitral stenosis and mitral insufficiency, together with a new murmur of tricuspid insufficiency were heard One year and nine months after the first operation, exploration of the mitral valve disclosed that the lateral commissure had refused A fairly adequate split was obtained and the patient has been markedly improved

Case No 292 (G A , N Y. Hospital History No 710689) a 33 year old woman, had a mitral valvulotomy at another hospital three years before admission. The surgeon thought the split had not been optimal The patient was improved for six months, then, associated with a pregnancy, symptoms recurred When admitted to The New York Hospital exertional dyspnea, par

oxysmal nocturnal dyspnea and hemoptysis were the major symptoms The murmurs of mitral stenosis mitral insufficiency and tricuspid insufficiency were present. A second exploration of the mitral valve was undertaken and a satisfactory split was obtained without increasing the small degree of mitral insufficiency The patient was improved by the operation

Four of these patients were initially improved by the first operation but then their conditions regressed The duration of improvement varied from six months to five years One patient was probably not helped by the two operations Good splits were obtained in four patients including the one who did not appear to be improved afterward In one patient the split was only fair but the patient was nevertheless improved for six months at which time symptoms recurred during a pregnancy

Three patients were markedly improved by the second mitral valvulotomy one moderately so and one was unchanged In three patients the surgeon thought that the valve had become more distorted since the first operation In one of these patients Aschoff bodies were present in the auricular appendage at the time of the first operation Aschoff bodies were not found in the atrial appendages of the other two patients In one patient there had been refusion of the lateral commissure

It is concluded that a second mitral valvulotomy is of benefit to certain properly selected cases It may help patients in whom the mitral leaflets have refused or in whom the valve has been further distorted and stenosed by continuation and progression of the rheumatic process A second operation may also be beneficial if the original split was inadequate

GALLBLADDER DISEASE AND MITRAL STENOSIS

The incidence of gallbladder disease has been found to be high in patients with mitral stenosis causing attacks of acute cholecystitis before mitral valvulotomy or at times in the post operative period Observations relating to this have recently been made by Frank Glenn M D and Frank Redo M D Forty three of the 300 patients who were subjected to operation for mitral stenosis had gallbladder disease demonstrated by one or more of the following methods Oral cholecystography or intra

venous cholangiography, at operation, or postmortem Thi
two of these patients had gallbladder disease demonstrated
operation

The majority of patients who were operated upon for mit
stenosis were women between the ages of 26 and 45 Gallblad
disease was demonstrated in 14 8 per cent of these women It
our impression that mitral stenosis pre-disposed to gallblad
disease in these patients There were many episodes of ac
cholecystitis in the postoperative period, some requiring em
gency cholecystectomy The differential diagnosis of right upp
quadrant pain in the postoperative period was usually betwe
acute cholecystitis and an enlarged liver due to heart failu
A preoperative cholecystogram was of great value in arriving
the correct diagnosis

As a result of this experience, the following policy is follow

1) The biliary tract is evaluated in all patients being co
sidered for mitral surgery

2) Unless there are urgent indications for immediate c
rection of the mitral stenosis, the gallbladder disease is attack
first After convalescence of three weeks or more, mitral valvu
tomy is then performed

PATIENTS WHO HAD MITRAL VALVULOTOMY AFTE BEING CURED OF SUBACUTE BACTERIAL ENDOCARDITIS

In the first 100 patients operated upon for mitral stenosis, the
were no patients who had suffered from subacute bacterial end
carditis In the second and third hundred patients, there we
two in this category

The first patient, Case No 278 (E C, N Y Hospital Histo
No. 738565), died fourteen months after mitral valvulotomy an
was not improved Her clinical course and autopsy are discuss
in Part III A photograph of the mitral valve in reproduced
Figure 9 The pathologist could not find definite anatomic
evidence of subacute bacterial endocarditis which had occurre
eight years previously and been cured The areas of erosion
the leaflets of the mitral valve were not considered related



Figure 9 In this figure is reproduced a photograph of the mitr
of Case No 278 (E.C. New York Hospital History No 738568) I
of the valvulotomy performed fourteen months earlier cannot be d
The protocol including autopsy findings are found in Part III p 1!

that infection but to represent degeneration in calcified portions of a valve severely damaged by rheumatic heart disease

The other patient Case No 303 (A M N Y Hospital History No 409781) was a 44 year old woman who was accepted for mitral valvulotomy because of moderate exertional dyspnea and two embolic episodes one to the left kidney two and a half years previously and another resulting in a severe hemiparesis ten months after the first embolic episode The patient was on digitalis Auricular fibrillation was present. Murmurs of mitral stenosis and mitral insufficiency were heard The lungs were clear the liver was not palpable there was no ankle edema There were residua of the cerebral embolism The heart was enlarged in the x ray photograph of the chest The electrocardiogram showed left axis deviation and incomplete right bundle branch block The patient was completely inactive

At operation the mitral valve area was increased from 0 8 sq cm to 3.5 sq cm with a slight increase in the mitral insufficiency that had been present before the split The post operative course was smooth

The follow up period in this patient was not long enough to evaluate adequately the result of operation when evaluations in this series were closed However a year has now elapsed and the patient s status remains unchanged The incapacitation due to the stroke remains the main problem On the positive side of benefit there have been no further embolic episodes over this short follow up period

Section IV

SUMMARY

In the 200 patients in this part of our report selected for mitral valvulotomy, there were 150 women and 50 men. The youngest patient was 19 years of age and the oldest 63. There were 27 patients over 50 years of age. There was a total of 12 deaths in the 200 patients either during the operation, or during the first 30 days of the postoperative period, and before discharge from the hospital. An additional 12 patients were operated upon during pregnancy and the results were analyzed separately. Fourteen patients were subjected to thoracotomy and/or cardiotomy without any operative procedure on the mitral valve. Three of the patients in this category died during the immediate postoperative period. Three patients were lost to follow up. Of the 200, one hundred and seventy have been repeatedly examined and evaluated to provide most of the information for this report.

Autopsy was performed on nine of the 12 patients who died. Seven deaths were associated with cardiac failure that appeared to be due either to the burden of the operation, or to changes that it induced. An example of the latter was a patient who also had aortic stenosis. Another example was a patient with an induced adhesive carditis* who did not tolerate the dissection necessary to expose the auricular appendage. The procedure had to be abandoned and death occurred 12 hours later. Thrombus formation within the left auricle was directly or indirectly the cause of death in four patients. One death was due to unrecognized and unsuspected sarcoidosis involving the heart.

The estimates of the effect of mitral valvulotomy were as follows.

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* The adhesive pericarditis resulted from the introduction of talcum powder into the pericardium before admission to our Center.

1 One hundred and sixty of 169 patients in the opinion of the surgeon had satisfactory valvulotomies 83 7 per cent of these 160 were improved

2 79 4 per cent of 170 of the patients followed were improved by operation 17 0 per cent were unchanged and 3 6 per cent were worse

3 81 9 per cent of the women were improved as compared to 72 1 per cent of the men

4 87 7 per cent of 89 patients exhibiting normal rhythm were improved and 70 4 per cent of 81 patients having auricular fibrillation

5 The degree of stenosis of the mitral valve had a direct relationship to what the surgeon believed he had accomplished and the improvement that resulted 98 1 per cent of patients with a tight stenosis were improved whereas in those patients with a moderate stenosis 87 2 per cent were improved

6 Calcification of the mitral valve was present in 36 (83 7 per cent) of 43 men and in 64 (55 2 per cent) of 116 women in 159 patients in whom the surgeon stated it to be absent or described it if present. A greater proportion of those without calcification were improved than those with it. The amount of calcification present often indicates the severity of the deformity of the valve

7 Cardiac murmurs carefully described provide valuable information in evaluating patients for operation but alone are not dependable as criteria.

8 The findings at operation have demonstrated that pure mitral stenosis without other valve defects is usually accurately diagnosed preoperatively The murmurs associated with it may be relied upon If mitral insufficiency is present and if other valves are involved then the conclusions reached by the clinician before operation may not be so exact

9 Approximately 80 to 85 per cent of 170 patients had marked relief from their presenting symptoms In most instances the presenting symptoms were those of pulmonary edema, paroxysmal nocturnal dyspnea peripheral emboli progressive dyspnea progressive early fatigability and hemoptysis

10 If mitral insufficiency is absent or minimal, valvulotomy may give rise to some degree of insufficiency, or may increase it Whether the patient will be improved is dependent largely upon the degree of stenosis which was present and the adequacy of the split which was obtained

11 If mitral insufficiency is moderate to marked then valvulotomy is likely to result in its increase, and consequently less improvement may result even though the stenosis is completely relieved

12 Insufficiency of the mitral valve due to shortened chorda tendineae may be improved by dividing them

13 Insufficiency of the mitral valve due to destruction and scarring of the leaflet is rarely improved by valvulotomy

14 Twenty of the 170 patients had signs and symptoms pointing to "Postvalvulotomy Syndrome" Its occurrence is unpredictable and without specific explanation

15 Ninty-five patients exhibited normal rhythm before operation, in 45 of these auricular fibrillation occurred, either during operation or in the postoperative period Thirty-nine (86 7 per cent) reverted to normal rhythm before discharge from hospital Accordingly, only six of the 45 patients in whom auricular fibrillation occurred postoperatively were discharged with this rhythm

16 Twenty-two patients were thought to have had pulmonary infarction before operation, 12 exhibiting auricular fibrillation and 10 normal rhythm Only three of these have had similar episodes during the follow up period after operation

17 Forty-five patients have had a total of 62 systemic emboli before operation Only one of this group has had an embolus since operation

18 Eight patients who had not had systemic emboli before operation had one or more systemic emboli either during or after mitral valvulotomy

19 Five patients who did not have pulmonary emboli before operation had such episodes afterward

20 Seven patients without evidence of previous emboli were found to have thrombus material in the left auricle at the time of operation, none of these patients suffered emboli subsequently

21 Aschoff bodies were found in biopsies taken at operation or postmortem in 57 of 191 patients Thrombi were over twice as common in patients with Aschoff bodies as in those without them The incidence of Aschoff bodies was greater in those patients who exhibited normal rhythm than in those having auricular fibrillation

22 Five patients had thoracotomies but the heart was not entered Nine patients had cardiotomies but because of the degree of mitral insufficiency operation was ineffective Eight of these patients were estimated before operation to have considerable insufficiency but exploration was undertaken with the hope that an operable valve would be found

23 Twelve patients had mitral valvulotomies while pregnant Ten of these were thought to have been benefited and thereby better able to tolerate the remaining period of pregnancy and delivery Two patients delivered prematurely one infant died Two patients had episodes of acute rheumatic fever shortly after operation

24 Second operations for persistent or recurrent mitral stenosis were undertaken in five patients four were improved and one remained unchanged

25 Twelve patients 55 or more years of age had mitral valvulotomies All but three had some concomitant disease of significance Five patients were markedly improved four remained unchanged one reverted to unchanged status after initial improvement and two were made worse One 63 year old man incapacitated by frequent recurrent attacks of pulmonary edema of increasing frequency sustained a good operative split of the mitral valve He has suffered no attacks of pulmonary edema up to 8 months after operation

Section V

COMPARISON OF RESULTS OF MITRAL VALVULOTOMY IN THE FIRST 100 PATIENTS WITH THE RESULTS IN THE SECOND AND THIRD HUNDRED PATIENTS

he preoperative diagnoses of the valve lesions were more
ried in the second two hundred patients than in the first 100
here was also a higher percentage of patients exhibiting tri-
spid insufficiency, reflecting the larger number of patients in
more advanced stage of their rheumatic heart disease Three
itients in the second group and only one in the first group were
ought on clinical grounds to have tricuspid as well as mitral
enosis

It is seen in Table 23 that a somewhat higher percentage of
itients was improved and a lower percentage made worse in
e second group One reason for the improvement rate was
nprovement in surgical technique The higher mortality in the
cond group reflects the selection of certain patients who were
ore advanced in their disease for operation

In the following six analyses slightly better results were ob
ined in the second two hundred patients than in the first one
indred patients

1) Improvement rate was greater according to the classification
groups as provided for by the New York Heart Association

2) Improvement rate was greater in the two rhythm groups,
amely, normal rhythm and auricular fibrillation

3) Improvement with respect to sex was higher in the women
i both groups than in the men, but a higher percentage of males
as improved in the second and third hundred patients, namely,
2 1 per cent, compared with 56 9 per cent in the first

TABLE 23

COMPARISON OF OPERATIVE MORTALITY AND IMPROVEMENT IN THE FIRST 100 AND THE SECOND AND THIRD HUNDRED PATIENTS

	First 100 Per Cent		*Second and Third Hundred Per Cent*	
Follow-up Mortality Rate (at operation and in first month)	3		6	
Markedly Improved	41	72% improved	63.3	79 4% improved
Moderately Improved	31		14 1	
Unchanged	17		12.9	
Improved → Unchanged	4		4 1	
Improved → Worse	1		0.6	
Unchanged → Worse	1	7% worse	0.6	3.6 % worse
Worse	5		2.4	

4) The improvement rate was greater in the second and third hundred patients than in the first 100 patients not only in patients in whom the valve was estimated at operation to be tight mitral stenosis" but also in those in whom the valve was estimated as moderate stenosis

5) The improvement rate was greater both in patients with *marked* calcification and also in those with *no* calcification in the second and third hundred patients than in the first 100 patients but was approximately the same in the two series in those with *moderate* or *slight* calcification

6) The percentage of patients obtaining improvement with respect to their presenting symptoms was greater in the second and third hundred patients than in the first 100 patients

In both series an adequate split in a tight valve resulted in a high percentage of improvement (80 per cent 88 9 per cent respectively) In the first series *11 patients* with tight valves did *not* have good splits and only five of these 11 were improved

In the second series, only *one patient* with a tight valve did *not* have an adequate split and the status of this patient was unchanged by operation In both series, approximately 70 per cent of patients with moderate stenosis and in whom good splits were secured was improved In the first series, three of four patients having moderate stenosis, and what was estimated by the surgeon as adequate splits, were improved, but none in this category were improved in the second series In both series, there was no improvement in patients who had little or no stenosis even though some increase in the size of the valve was achieved

The improvement rate for patients with the preoperative clinical diagnosis of pure mitral stenosis was the same in both series A higher percentage of patients with mitral stenosis and mitral insufficiency were improved in the second series (74 5 per cent) compared with 66 6 per cent in the first series All patients with mitral stenosis and slight aortic insufficiency were improved in both series One of three patients with mitral stenosis and aortic stenosis in the first series, and three of four with this combination in the second series, were improved by the mitral valvulotomy A similar percentage of patients with mitral stenosis, mitral insufficiency and aortic insufficiency was improved in both series A higher percentage of patients with tricuspid insufficiency was improved in the second series, namely, 76 8 per cent, compared with 64 3 per cent in the first series

The results of operation related to the presence of mitral insufficiency found by the surgeon at operation are listed in Table 24 The results in the two series are similar in most categories Increasing the mitral insufficiency does not seem to alter the improvement rate

There was no difference between the two series in the analysis of improvement and the fate of the preoperative murmur thought to represent aortic insufficiency and its disappearance, persistence, or initial diagnosis after operation (Table 25)

There was a similar percentage of significant chest pain in both series (18 8 and 16 5 per cent) There were three patients with acute rheumatic fever in the follow up period after the operation in the first series and four in the second, in which

there was an additional patient with the diagnosis of probable acute rheumatic fever

The percentage of patients exhibiting normal rhythm preoperatively who developed auricular fibrillation after operation in both series was the same namely 45 and 47 8 per cent respectively In the first series 70 per cent of these and in the

TABLE 24

Mitral Insufficiency at Operation its Increase Decrease or Lack of Change and Improvement in the Two Groups

M I as Palpated by Surgeon at Operation		*First 100 Cases*		*Second and Third Hundred Cases*	
		77 Cases Analyzed		*139 Cases Analyzed*	
Before Valvulotomy	*After Valvulotomy*	*No of Cases*	*Per Cent Improved*	*No of Cases*	*Per Cent Improved*
None		39	82.1	72	88.9
None	None	36	80.8	57	87.6
None	Some	3	100.0	15	93 4
Slight to moderate	Unchanged or decreased	21	71 4	53	52.8
Slight to moderate	Increased	7	71 4	16	62.4
Marked	Unchanged or decreased	5	80 0	10	100.0
Marked	Increased	5	40.0	4	50.0

TABLE 25

Aortic Insufficiency Murmur and Improvement in the Two Groups of Patients

State of A I Murmur Postoperatively	*First 100 Cases*		*Second and Third Hundred Cases*	
	(14 Cases had Preoperative A I Murmur)	*No of Cases Improved*	*(23 Cases had Preoperative A I Murmur)*	*No of Cases Improved*
Disappeared	3	2	10	8
Unchanged	11	7	13	13
First heard postoperatively	7	5	[illegible]	7

second series 86 7 per cent reverted to normal rhythm In the first series 35 6 per cent received quinidine and 66 8 per cent in the second series

In the first series, only two of 22 patients (9 1 per cent) who had preoperative pulmonary emboli had postoperative recurrences Three (13 6 per cent) of the 22 patients in the second series who had preoperative pulmonary emboli had postoperative recurrences There were no postoperative arterial emboli in any of the 17 patients in the first series who had them before operation There was one postoperative recurrence in the second series, in which 45 patients had preoperative systemic emboli

Of the first 100 patients, there were nine postoperative emboli (eight systemic, one pulmonary) in those patients who sustained none preoperatively, in the second and third hundred patients, eight patients who had none preoperatively, had postoperative pulmonary and/or systemic emboli

In the first series there were five pregnant patients One was not benefited In the second group, ten of 12 pregnant patients were improved

In 83 patients analyzed in the first series, 18 (21 7 per cent) had Aschoff bodies in the left auricular appendage Fifty-two (31 1 per cent) of 167 patients in the second series had Aschoff bodies In both series this lesion occurred more frequently in younger patients and in patients exhibiting normal rhythm (72 and 73 6 per cent, respectively)

The duration of significant postoperative fever was six days in the first series and ten in the second Postoperative complications were similar in the two series

The incidence of left auricular thrombi was similar in both series (16 8 and 16 per cent, respectively) as were the percentages of these patients exhibiting left auricular thrombi at operation who had arterial or pulmonary emboli at operation, or within the follow up period (26 7 and 30 per cent, respectively)

In the first series, the incidence of thrombi in the left auricle was 17 per cent both in patients with and in those without Aschoff bodies In the second series, the incidence of thrombi was higher in those without Aschoff bodies (10 9 and 23 7 per cent, respectively)

There was a difference in results in the two series in the analysis of Aschoff bodies and Improvement (Table 26) and Age and Improvement (Table 27) The reason for the better results in the second and third hundred patients when Aschoff bodies were present is not known

TABLE 26

ASCHOFF BODIES AND IMPROVEMENT IN THE TWO GROUPS

	First 100 Cases	*Second and Third Hundred Cases*
Patients who had no Aschoff bodies	65 patients 74 per cent improved	115 patients 76.5 per cent improved
Patients who had Aschoff bodies	18 patients 61 per cent improved	52 patients 84.8 per cent improved

TABLE 27

AGE AND IMPROVEMENT IN THE TWO GROUPS

Age Group Years	*In 85 of the First 100 Patients*	*In 170 of the Second and Third Hundred Patients*
	Per Cent Improved	*Per Cent Improved*
21 30	83.3	89.8
31-40	69.6	90.2
41 50	68.9	71 4
> 51	80.0	51 7

Three patients in the first series and five in the second had only thoracotomies without operation on the mitral valve Left auricular thrombi adherent pericardium calcification of the auricular wall and finally left auricular appendages that could not be entered were reasons for the inability to complete the operation in both series. One patient in the first series and nine in the second had cardiotomies without operation on the mitral valve All these patients had marked mitral insufficiency

Two of the first 100 and 12 of the second and third hundred

were over 55 years old Both of the earlier cases were improved Five of the 12 in the second and third hundred patients were markedly improved, one was improved and then reverted to an unchanged status, four remained unchanged, and two became worse Nine of the 12 patients in the second and third hundred had serious concomitant disease It became apparent as experience accumulated that many older patients do well even when other diseases are present

Moreover, as experience accumulated right heart catheterization was done less frequently, because it often was unable accurately to answer questions which were left in doubt after clinical evaluation alone Angiocardiograms were also resorted to less frequently No patients with healed subacute bacterial endocarditis came to operation in the first one hundred cases Two patients fell into this category among the second and third hundred patients

Patients with thrombi in the left auricle at the time of operation frequently improved after operation and many did not have embolic phenomena postoperatively These patients were frequently given anticoagulant therapy after operation If the thrombus was molested, an attempt was made to wash it out, for in such cases there was a tendency for new clot to form and propagate through the mitral valve Blood lost in flushing out the thrombotic material was replaced by rapid transfusion Clots in the auricular appendage were removed The auricular appendage was obliterated at its base by securing the purse-string ligature used during the procedure to control bleeding from the auricle

It became apparent as more mitral valvulotomies were performed that the ideal valve for valvulotomy is one in which the valve leaflets are fused These valves can usually be opened with a good functional valve resulting On the other hand, if the valve ring and leaflets are damaged and distorted, the operative split often results in the induction of mitral insufficiency, or in its increase if it had been present before the split

Section VI

DISCUSSION

The surgical correction of mitral stenosis using the approach of Souttar has been demonstrated by Bailey Harkens and many others to be a highly satisfactory procedure It is a very worth while advance in therapy The degree of success to be attained in this endeavor seems to be dependent chiefly upon first, the selection of patients second the accomplishment of the surgical procedure and third the observation and management of the patients afterward.

The selection of patients for valvulotomy rests in the hands of internists and cardiologists They together with the pediatri cians have cared for these patients since they had their first manifestations of rheumatic fever They from long experience have a basis for recognizing when medical management of mitral stenosis should be supplemented by surgery The reported experi ence from many groups have established criteria for the selection of the ideal candidate for operation Because patient care does lend itself to assembly line tactics the internist or cardiologist and the surgeon require not only each other s abilities but those of the roentgenologist the cardio-physiologist and the anesthesiol ogist.

In reaching a decision concerning an operation for mitral stenosis information that will influence any step throughout the entire undertaking is highly desirable The more complete this can be the greater will be the success with which it is accom plished The cardiologist knows the clinical course of his patient and much about his heart The roentgenologist frequently finds something unexpected as well as confirms many of the cardiolo gist s findings Cardiac catheterization and angiocardiography from time to time will answer some questions that arise Not all patients are ideal candidates and there needs be a sliding scale

to indicate where risks are and to balance them against prognosis for those circumstances Anesthesia tolerance is a part of the operation and merits careful consideration The surgeon accurately informed about the patient can predict with almost the same degree of accuracy the benefits and the risk of operation The selection of patients for mitral valvulotomy is best done by an able and cooperative group of physicians who bring together all the relevant information that it is possible to obtain

The preoperative preparation and the selection of anesthesia are dependent upon the individual patient's requirements The administration of anesthesia is an integral part of the operative procedure Skill in keeping this burden at a minimum for the poorly compensating heart with pulmonary edema is most important The surgeon's objective is to open the stenosed valve as adequately as possible so that the area of the valve orifice approaches that which would be normal for the patient Anticipation of and provision for hazards along the way are the best insurance for a low morbidity of complications and mortality rate Mitral insufficiency associated with stenosis is sometimes diminished by valvulotomy, but in general it is poorly dealt with by any closed cardiac operative procedure The clinical means for evaluating the degree of mitral insufficiency which is present is unsatisfactory with the result that patients are both refused and accepted for operation on inadequate information The same is true concerning thrombus formation within the left auricle These are examples of conditions that if more were known about before operation the surgeon could avoid some exploratory procedures The best opportunity to open the mitral valve is at the primary operation Therefore, the procedure should be as complete and thorough as feasible Secondary operations are difficult and hazardous and often unsatisfactory

Close observation and expert management following surgery provides for optimal benefit to the patient and affords a source of information that is valuable in evaluation and treatment of other patients with mitral stenosis Many individuals with mitral stenosis have been restricted in activity for long periods before operation Some patients afterward will tend to overdo and exceed

their hearts capacity for exercise Others need encouragement and guidance not to become less active Medication and diet may be changed gradually over a period of weeks or months with greater benefit than if this is done suddenly

All concerned with this endeavor will be better informed by first hand evaluation of patients for as long as possible after operation There are many questions that will require a much longer time to answer than the decade since the surgical therapy of mitral stenosis began to be widely used A great deal has been learned in this period Results are encouraging Improvement in selection of patients the surgical procedures and the care afterward can best be advanced by critical evaluation of results The total effect of valvulotomy must be determined by trying to ascertain whether or not it has relieved symptoms overcome disability and prolonged life as compared to the course of those patients not treated by this procedure

PART THREE

HE LONG TERM FOLLOW UP OF THE FIRST ONE HUNDRED PATIENTS WHO HAD MITRAL VALVULOTOMIES

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INTRODUCTION

To recapitulate, the results with respect to benefit from mitral valvulotomy in 85 of the first one hundred patients (1951-1953) were analyzed in Part I of this monograph These 85 patients all had operations on the mitral valve and survived the postoperative period The remaining 15 patients not included in that analysis, but discussed separately, consisted of pregnant patients (five), those only explored (four), those who died on the table or within the first postoperative month (three), those who could not be properly evaluated (two), and one in whom follow up was not successful

In Part III will now be presented further data about the 85 patients analyzed in Part I, patients who have now been followed an average of fifty months The shortest period of follow up is 13 months* and the longest 79 months The course of the patients in the other categories will be discussed separately as in Part I

* The shortest follow ups were in those patients who died

Section 1

MORTALITY AND AUTOPSY MATERIAL IN THE LONG TERM FOLLOW UP

Again to recapitulate none of these 85 patients who survived the postoperative period died during the shorter term follow up (Part I) However at the end of the present follow up period (an average of 50 months) 20 patients had died resulting in a mortality of 23 5 per cent The average time of death in these 20 patients was 34 months after operation

The course of these 20 patients is tabulated in Table 28 Autopsy findings in the 11 patients in whom this information is available are recorded in this table The causes of death as accurately as could be determined from the clinical course and/or autopsy findings are listed in Table 29

The estimated status at the time of the shorter term follow up of these 20 patients who have since died is tabulated in Table 30

Of these 20 patients shown in Table 30 12 were estimated to have had good splits at operation three fair splits and five poor splits

It appears that the mortality rate in the longer follow up cannot be predicted either from the shorter term evaluation or from the adequacy of the operative split as estimated by the surgeon at the time of operation

ROLE OF EMBOLI IN THE 20 PATIENTS OF THE ORIGINAL ANALYSIS OF 85 WHO HAVE DIED DURING THE LONG TERM FOLLOW UP

Four of the 20 deaths in the long term follow up were related to emboli Two died in heart failure with recent pulmonary emboli One patient died after a leg amputation necessitated by a saddle embolus Another died of a cerebral embolus None of

these patients had had thrombus material in the left auricular appendage at the time of operation

To recapitulate (Part I, page 20), two of the three operative deaths were associated with major embolic episodes One patient did not react well after operation and had a right hemiplegia This may have been caused by embolization of calcific material from the valve There were no thrombi in the left atrium at the time of operation, and the patient did not have embolic phenomena in the preoperative period The second patient, who was a poor operative risk, had a poor split at operation and a stormy course thereafter She died 23 days postoperatively Autopsy showed widespread thrombi in the heart, kidneys, pancreas and spleen There was an area of early softening in the brain There had been no thrombi in the left auricle at the time of operation

Thus two of the three operative deaths and four of the 20 deaths in long term follow up period were related to recent emboli

TABLE 29

CAUSES OF DEATH OF 20 PATIENTS IN THE LONG TERM FOLLOW-UP OF THE FIRST 85 PATIENTS HAVING MITRAL VALVULOTOMIES ANALYZED IN PART I

Cause	Number
Heart Failure	10
Heart Failure and Pulmonary Embolus	2
Postoperative death after amputation necessitated by saddle embolus	1
Cerebral Embolus	1
Acute Pulmonary Edema	1
Carcinoma of Cervix	1
Pulmonary Arteritis	1
Undetermined	2
Death after second valvulotomy (cause not determined)	1
	20

TABLE 30

ESTIMATED STATUS AT THE SHORTER-TERM FOLLOW-UP OF THE 20 PATIENTS WHO HAVE SINCE DIED

Status	Number
Markedly improved	6
Moderately improved	3
Unchanged	6
Improved going to Worse	1
Worse	4
	20 Patients

Various lesions which were probably due to emboli were found in many of the patients who came to autopsy These lesions were old and probably did not contribute directly to the patients death

Undoubtedly there were embolic episodes that could not be diagnosed at autopsy Some of the deaths in patients in whom autopsies were not obtained may have been due to this cause

STATUS OF THE MITRAL VALVE IN PATIENTS WHO CAME TO AUTOPSY OR HAD SECOND OPERATIONS DURING THE LONG TERM FOLLOW UP PERIOD

Eleven autopsies were performed in patients who survived the immediate postoperative course and died during the long term follow up period All of these patients died after the short term follow up had been closed and are included in statistics of the present long term follow up Seven autopsies were performed at The New York Hospital and four at other hospitals* (Table 28) Details are found in Table 28

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*We wish to thank the physicians and hospitals supplying these data to us.

TABLE 28

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW-UP

Case No N Y Hospital History No	*Sex Age at Time of Operation*	*Pre operative classification*	*Reason for Operation*	*Pre-operative Valvular Diagnosis*	*Valve Size Before Operation*	*Valve Size After Operation*	*Adequacy of Split*	*Value Calcification*	*Comments on Operation*	*Time of First Follow up and Evaluation*
Case No 7 H McG 75185	Male 16	III C	Cerebral Embolus 1 yr previously Moderate exertional limitation	M S M I	Less than 0 5 cm^2	Admitted index finger (area over 2 cm^2)	Good	+	Transient tachycardia	2 years, 4 months Unimproved, then worse
Case No 9 F L.* 611897	Male 35	III C	An attack of pulmonary edema Exertional limitation Hemoptysis	M S	Less than 1 cm^2	Admitted second joint	Good	+	Mitral Insufficiency	2 years 4 months Markedly improved

* A detailed account of this patient s course is found in Part I Section III p 50

TABLE 28 (continued)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW UP

Case No N Y Hospital History No.	Postoperative Course to Death	Cause of Death	Time of Death After Operation	Autopsy
Case No 7 H McG 75485	Unchanged then worse Increase in heart failure	Sudden death at home.	4 years, 3 months	Not obtained.
Case No 9 F L 614897	Marked increase exertional tolerance Preoperative orthopnea (2 3 pillows) changed to no orthopnea. No pulmonary edema Slight hemoptysis Cardiac catheterization (13 months) showed improvement Attacks of subacute cholecystitis. Improved for about 2 years Then less exercise tolerance. Acute pulmonary edema 2 years 10 months after operation. The results of cardiac catheterization at this time were similar to those obtained before operation Suspicion that valve had resealed and he was accepted for second valvulotomy Preoperative diagnosis M.S. M.I. (soft murmur) T.I. Before and during induction and during first phase of operation, auricular flutter fibrillation and auricular paroxysmal tachycardia developed, then reverted to normal rhythm Organized clot removed from auricular appendage. Slight M.I. noted Valve area less than 1.0 cm² Very distorted, thick, calcified valve. Orifice increased in size, M.I. also increased Auricular fibrillation developed on the first postoperative day Excellent recovery postoperatively	Patient complained of not feeling well on arrival at home after discharge 16 days after second valvulotomy Returned to the hospital at once; profuse perspiration, burning precordial pain Sudden loss of consciousness. Emergency therapy of no avail and patient died before he could be admitted to hospital.	3 years after first mitral valvulotomy and 16 days after second valvulotomy	Thrombus in base of left auricular appendage A similar thrombus, 5.4x1.5 cm. in left auricle (not noted at operation) Very distorted mitral valve A split was noted postero-medially extending to the auricular wall. Tricuspid and pulmonary valves not remarkable. Slight scarring of aortic leaflets Dilatation of right auricle. Right ventricle of normal size Fairly severe atherosclerosis of coronary arteries Heart weight 580 gm Chronic pressure congestion and hemosiderosis of lungs. Small healed renal infarcts Cholelithiasis. No lesions in brain grossly or multiple sections

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW-UP

Case No N Y Hospital History No	*Sex Age at Time of Operation*	*Preoperative classification*	*Reason for Operation*	*Preoperative Valvular Diagnosis*	*Valve Size Before Operation*	*Valve Size After Operation*	*Adequacy of Split*	*Valve Calcification*	*Comments on Operation*	*Time of First Follow up and Evaluation*
Case No 10 R O C. 112362	Female 31	IV E	Incapacitating dyspnea	M S, M I	2 cm^2	Very little change	Poor	+		1 year, 1 month Worse
Case No 11 S Z. 30159	Male 30	II B	Hemoptysis, slight exertional limitation	M S, M I	1 5 cm^2	3 cm^2	Good	+	Adhesive pericarditis noted at operation	2 years, 3 months Worse

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW-UP

Case No. N Y Hospital History No.	*Postoperative Course to Death*	*Cause of Death*	*Time of Death After Operation*	*Autopsy*
Case No 10 R O'C 112362	Continued downhill course with intractable heart failure	Probably heart failure.	2 years, 2 months.	Not obtained
Case No 11 S Z 30159	Patient did very poorly after operation Hemoptysis continued and exertional limitation became severe, although it had previously been mild.	Heart failure Patient had stopped digitalis on his own two and one half weeks before admission in extremis.	2 years, 5 months	All chambers dilated. Right and left ventricular walls hypertrophied (6 mm 16 mm) Tricuspid and pulmonic valves essentially normal. Mitral valve leaflets thickened calcified; some of the calcified areas were eroded. Aortic valve commissures showed fusion, thickening, calcification. Slight patchy atherosclerosis of coronary arteries. Heart weight 570 gm. Moderate pulmonary atherosclerosis. Pulmonary edema, chronic passive congestion of lungs, liver spleen. Bronchopneumonia. Two large mediastinal nodes containing healed tuberculosis.

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW-UP

Case No N Y Hospital History No	*Sex Age at Time of Operation*	*Preoperative classification*	*Reason for Operation*	*Preoperative Valvular Diagnosis*	*Valve Size Before Operation*	*Valve Size After Operation*	*Adequacy of Split*	*Valve Calcification*	*Comments on Operation*	*Time of First Follow up and Evaluation*
Case No 18 M G 263269	Female 15	III D	Dyspnea	M S	Less than 0 5 cm^2	2 5—3 cm^2	Very satisfactory	⊕	Slight M I	1 year, 8 months Markedly improved

TABLE 98 *(continued)*

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW UP

Case No. N. Y. Hospital History No.	*Postoperative Course to Death*	*Cause of Death*	*Time of Death After Operation*	*Autopsy*
Case No 18 M G 263269	Markedly improved for 2 years, then regressed, but not to as severe failure as before operation Patient was planning an auto trip. Pulmonary edema suddenly developed that was fatal within one day	Acute pulmonary edema.	4 years, 7 months.	Autopsy report performed at the Stamford Hospital Stamford, Conn Heart markedly enlarged. Complete synechia of pericardial space. Very large left atrium. Right atrial musculature thickened. Not dilated. Aortic, pulmonary tricuspid valves not remarkable Minimal nodular thickening of free borders of tricuspid valve. Marked mitral stenosis with calcification. Orifice is irregular and slit-like, 3 cm. in length between two zones of densely thickened and calcified tissue Posterior commissure is markedly thickened and calcified. Anterior commissure less calcified but equally firmly fixed. The mitral valve opens easily only 2 to 3 mm. Calcification of atrial wall near valve No left ventricular hypertrophy Marked right ventricular hypertrophy Slight interstitial myocardial fibrosis Patent coronaries. Heart weight, 450 gms. Left pleural effusion. Focal scars, atelectasis, emphysema and chronic passive congestion of lungs. Pulmonary edema. Bronchopneumonia Biliary system not remarkable. Congestion of liver

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW-UP

Case No N Y Hospital History No	*Sex Age at Time of Operation*	*Preoperative classification*	*Reason for Operation*	*Preoperative Valvular Diagnosis*	*Valve Size Before Operation*	*Valve Size After Operation*	*Adequacy of Split*	*Valve Calcification*	*Comments on Operation*	*Time of First Follow up and Evaluation*
Case No 20 I M 623950	Female 10	IV E	Recurrent pulmonary edema and ascites Dyspnea Pulmonary edema	M S, M I T I	Less than 1 cm²	2—3 cm²	Good	⊕	2 clots washed out of left auricle No M I found B P low during split At end of operation, anesthesiologist thought patient's condition improved	1 year, 1 month

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW UP

Case No. N. Y. Hospital History No.	*Postoperative Course to Death*	*Cause of Death*	*Time of Death After Operation*	*Autopsy*
Case No. 20 E. M. 623950	Continued intractable heart failure.	Heart failure.	2 years, 1 month	Dilated right atrium. Tricuspid valve admitted only the tip of the finger. Evidence of *tricuspid insufficiency*. Right ventricle 1 cm. thick. Pulmonic valve normal. 3x2x2 cm. firmly attached thrombus in left auricle at sight of resected appendage. Mitral orifice calcareous. *Orifice 3x5 mm.* Marked distortion fusion of medial and lateral cusps of aortic valve, resulting in bicuspid valve. Coronary arteries not examined. Pleural and abdominal *fluid*. Atelectasis of right middle and lower lobes. Congestion? Pneumonia? Anasarca. Old healed ileocecal tuberculosis. Cardiac cirrhosis of liver. *Absent gall* bladder. Stones in remnant of cystic duct in common hepatic and common bile duct. (Autopsy performed at U. S. Army Hospital, West Point, N. Y.) COMMENT: Prosector at autopsy thought that the tricuspid stenosis and insufficiency were important reasons for the patient's lack of improvement after operation.

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW-UP

Case No N. Y. Hospital History No	*Sex Age at Time of Operation*	*Preoperative classification*	*Reason for Operation*	*Preoperative Valvular Diagnosis*	*Valve Size Before Operation*	*Valve Size After Operation*	*Adequacy of Spl.*	*Valve Calcification*	*Comments on Operation*	*Time of First Follow up and Evaluation*
Case No 21 G P 621851	Male 38	III D	Dyspnea	M S, M I	3 mm by 1 cm	1 5 cm diameter	Good	+	M I present as 2 small jets	1 year, 5 months Marked improvement
Case No 28 M S 109107	Female 10	III D	Dyspnea orthopnea paroxysmal nocturnal dyspnea	M S M I	Over 2 cm²	Only slightly increased	Poor	0	Marked M I	1 year 5 months Unchanged

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW UP

Case No. N Y Hospital History No.	*Postoperative Course to Death*	*Cause of Death*	*Time of Death After Operation*	*Autopsy*
Case No. 21 G P 624851	Severe chest pain requiring paravertebral block. He was markedly improved until 4 months before death	Heart failure	3 years, 10 months.	Mitral valve partially admitted tip of finger. Surgical split noted. Mitral valve distorted and calcified. Aortic valve fusion of leaflets and calcification. Minor changes in tricuspid valve. Right and left ventricles were thick. Patent but sclerotic coronaries. Acute interstitial myocarditis. (Autopsy performed at the Mt. Vernon Hospital Mt. Vernon, N Y)
Case No 28 M S 109407	Continued downhill course	Heart failure	2 years, 11 months	Not obtained.

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW UP

Case No N. Y. Hospital History No	*Sex Age at Time of Operation*	*Pre operative classification*	*Reason for Operation*	*Pre operative Valvular Diagnosis*	*Valve Size Before Operation*	*Valve Size After Operation*	*Adequacy of Split*	*Valve Calcification*	*Comments on Operation*	*Time of First Follow up and Evaluation*
Case No 33 R B 632022	Male 51	III D	Dyspnea Hemoptysis	M S	Less than 1 cm²	Less than 2 cm²	Only Fair	⊕	Very small jet of M I Small piece of calcium lost into circulation No untoward effects	1 year, 1 months Unchanged
Case No 34 E. K 521356	Female 31	III D	Dyspnea	M S, M I	Less than 1 cm²	Over 2 cm²	Good	+	M I present before valvulotomy At least as much afterwards	1 year, 7 months Worse

TABLE 28 (continued)

Data on the 20 Patients Who Died in the Long Term Follow up

Case No. N. Y. Hospital History No.	Postoperative Course to Death	Cause of Death	Time of Death After Operation	Autopsy
Case No. 33 R. B. 632022	Never improved.	Probably heart failure and right pulmonary infarction.	2 years, 2 months	Autopsy performed at Goldwater Memorial Hospital, New York, N. Y. Chronic rheumatic heart disease, mitral stenosis, some mitral insufficiency, atheroma and calcification of the mitral valve, marked pleurisy, bronchopneumonia, right pulmonary infarction. Liver: Chronic passive congestion. Polycystic left kidney.
Case No. 34 E. K. 521356	Not improved by operation. Relentless failure and severe chest pain with episodes of cyanosis. Therapeutic dose of I[131] administered 20 months postoperatively. Hypothyroidism developed. Failure progressed.	Heart failure.	3 years.	Mitral cusps markedly thickened, shortened, fused. Fish-mouth mitral stenosis 1.5 cm. in diameter. Slight fusion of cusps of aortic valve. 3 polypoid nodules 3 mm. in diameter composed of fibrous tissue hanging from aortic valve. Free edges of tricuspid valve rolled and thickened. Left ventricular wall measures 14 mm., right ventricular wall 4 mm. Left atrium dilated to about three times normal capacity. Marked coronary atherosclerosis. Thick pleura, some alveoli lined with cuboidal epithelium with areas of squamous metaplasia. Heart failure cells, occasional red blood cells and mononuclears in alveoli. In one section alveoli are thickened by fibrous tissue. Fibrous replacement of thyroid. Marked sclerosis of abdominal aorta. Small amount of ascites. Microscopic examination of mitral valve showed fibrous tissue proliferation, new growth of capillaries and elastic fibrils.

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW UP

Case No N Y Hospital History No	*Sex Age at Time of Operation*	*Preoperative classification*	*Reason for Operation*	*Preoperative Valvular Diagnosis*	*Valve Size Before Operation*	*Valve Size After Operation*	*Adequacy of Split*	*Valve Calcification*	*Comments on Operation*	*Time of First Follow up and Evaluation*
Case No 35 R L 633856	Female 10	III D	Multiple strokes Dyspnea	M S M I	Less than 1 cm²	3 cm²	Excellent	+	Production of marked M I during split	11 months Unchanged
Case No 39* F S 611119	Female 21	III D	Dyspnea Ankle edema Ascites	M S M I A I	4 cm²	Same	No valvulotomy	0	Gross M I	9 months Explored only
Case No 43 H R 20635	Female 33	III D	Dyspnea and heart failure	M S M I	1 cm²	2 cm²	Poor	⊖	Large stream of M I made worse by operation	1 year 2 months Unchanged

*This patient is included for the sake of completeness It records the course of a patient who did not have a mitral valvulotomy because of marked mitral insufficiency and this is not included in the analysis of the group of 55 patients (see Part I p 22)

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW UP

Case No. N Y Hospital History No.	*Postoperative Course to Death*	*Cause of Death*	*Time of Death After Operation*	*Autopsy*
Case No 35 R L 633886	Not improved Admitted elsewhere 1 year after operation because of shortness of breath and nausea Patient considered to be IV E (New York Heart Classification) at that time. Had embolus to left cerebral hemisphere whil hospital	Cerebral embolus.	1 year 1 month	Autopsy not obtained
Case No 39 F S 614449	The patient was nchanged by the operation and congestive heart fail re got worse	Probably heart failure	2 years 9 months	Not obtained.
Case No 43 H R 26645	Congestive heart failure became progressively worse Patient had diabetes mellitus	Intractable heart failure Hyperchloremic acidosis Digitalis toxicity	1 year 8 months	Atria and right ventricle are dilated and hypertrophied. Right ventricle measures 6 mm at base Normal left ventricle. Mitral valve was heavily calcified with a slit-like orifice. Atheromas in pulmonary artery Tricuspid leaflets thickened. Free edges curled. Only minimal coronary atherosclerosis Heart weight 350 gm Chronic congestion of liver and lungs. Pulmonary edema Bilateral pleural effusions. Bilateral healed infarcts of the kidneys.

TABLE 28 (continued)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW UP

Case No N Y Hospital History No	*Sex Age at Time of Operation*	*Preoperative classification*	*Reason for Operation*	*Preoperative Valvular Diagnosis*	*Valve Size Before Operation*	*Valve Size After Operation*	*Adequacy of Split*	*Valve Calcification*	*Comments on Operation*	*Time of First Follow up and Evaluation*
Case No 11 N B 416162	Female 15	III C	Dyspnea Possible pulmonary infarct a month before operation	M S M I	9 mm by 3 mm	3 cm²	Good	0	No M I	1 year, 4 months Markedly improved
Case No 49 M I 571580	Female 39	III C	Dyspnea Heart failure	M S, M I T I	1 cm by 2 mm	3 cm²	Good	+		1 year 1 month Moderately improved
Case No 61 T D 651365	Male 15	III C	Fatigue Dyspnea Cough	M S M I, A I	1 5—2 cm²	Slight split in both commissures	Poor	⊕	Marked M I, worse after the valvulotomy	1 year Unchanged

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW UP

Case No. N Y H pital History No	*Postoperative Course to Death*	*Cause of Death*	*Time of Death After Operation*	*Autopsy*
Case No. 44 N B 646162	Marked improvement in all respects. Hemorrhage from cancer of cervix about a year after operation.	Inoperable cancer of cervix.	3 years, 3 months.	Not obtained. Communication from personal physician said death was from the cancer
Case No 49 M I 571889	Improved for about one year. Saddle embolus 1 year 1 month after operation. Conservative therapy. Heart failure increased	Unknown; probably heart failure.	3 years, 10 months.	Not obtained
Case No 61 T D 651365	Continued congestive heart failure. Repeated admissions. Tricuspid insufficiency developed.	Heart failure and pulmonary embolus	2 years, 8 months	All heart chambers dilated and thickened, the left ventricle the most (13 mm in thickness). Deformed mitral valve. No distinct residua of valvulotomy found. Marked calcification of the valve. Slight fusion of aortic cusps at commissures. Tricuspid valve thickened slightly. Dilated tricuspid valve ring. Microscopically, hypertrophy of myocardial fibers, a few small perivascular scars, and tiny areas of fresh necrosis. Heart weight 570 gm. Cardiac cirrhosis of liver. 1500 cc. peritoneal fluid, 1000 cc. in right pleural cavity. 300 cc. in left pleural cavity. Hyperemic bowel mucosa. A very recent pulmonary embolus, 10x8x6 cm. in left lower lobe. Moderate narrowing of coronary arteries.

A photograph of this mitral valve is reproduced in the frontispiece.

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG-TERM FOLLOW-UP

Case No., N.Y. Hospital History No.	*Sex, Age at Time of Operation*	*Preoperative Classification*	*Reason for Operation*	*Preoperative Valvular Diagnosis*	*Valve Size Before Operation*	*Valve Size After Operation*	*Adequacy of Split*	*Valve Calcification*	*Comments on Operation*	*Time of First Follow-up and Evaluation*
Case No. 71 R. C. 65332[illegible]	Female 26	III C	Cough Exertional dyspnea	M. S. A. I.	6 mm by 2 mm	3 cm²	Excellent	+	—	5 months Markedly improved

TABLE 28 (continued)

DATA ON THE 90 PATIENTS WHO DIED IN THE LONG TERM FOLLOW UP

Case No. N. Y. Hospital History No.	Postoperative Course to Death	Cause of Death	Time of Death After Operation	Autopsy
Case No 71 R. C. 653327	Continued to do well when seen 4 years, 5 months postoperatively during recovery from influenza and pneumonia. However, high fever recurred. A source of infection not definitely located. Despite maximal therapeutic effects, patient died in congestive failure and high fever 4 years, 6 months postoperatively. Organism not definitely identified.	Severe infection and congestive heart failure.	4 years, 6 months.	Heart weighed 380 gm. Right and left ventricular walls had thickness of 8 and 13 mm. Flabby myocardium. Marked narrowing of mitral valve with a slit-like opening 1.0 cm² in area. Thickened leaflets. Chordae tendineae are thickened, shortened and decreased in number. Right coronary cusp and the non-coronary cusp of the aortic valve were extensively fused but not insufficient. Widely patent coronary arteries. Microscopic: An interstitial myocarditis with 95% polymorphonuclear leukocytes. Not the picture of virus myocarditis or acute rheumatic fever. The myocarditis was probably an acute terminal episode. Lungs: Middle and lower lobes of right lung are markedly firm and bulky. Microscopic: Alveolar wall thickening with fibrous tissue. There was marked necrosis of the subendothelial structures of the small arteries, arterioles and capillaries. In some cases the lumina were occluded by thrombi and in some the intima was thickened by collagenous tissue. The media was usually thinned and distended or completely destroyed. The alveoli around the acute vascular lesions contained fibrin, leukocytes including many neutrophils and many erythrocytes. The pathologist thought the acute necrotizing pulmonary arterial disease might explain the clinical course for the last few weeks of the patient's life.

TABLE 28 *(continued)*

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW-UP

Case No N Y Hospital History No	*Sex Age at Time of Operation*	*Pre-operative classification*	*Reason for Operation*	*Pre-operative Valvular Diagnosis*	*Valve Size Before Operation*	*Valve Size After Operation*	*Adequacy of Split*	*Valve Calcification*	*Comments on Operation*	*Time of First Follow up and Evaluation*
Case No 71 I S 613696	Female 26	III C	Dyspnea, Heart failure	M S, M I	Less than 1 cm^2	3 cm^2	Good	+	Marked M I	6 months Markedly improved
Case No 92 C P 668518	Female 12	III C	Dyspnea, fatigue	M S M I	1 cm^2	3 cm^2	Good	+	Slight M I. after completing fracture	6 months Moderate improvement
Case No 96 M B 236153	Female 43	III D	Faint in head on exertion." Pulmonary edema	M S M I	1 5—2 5 cm^2	Same	Very slight tear	0	Marked M I found at operation. Surgeon believed relief of stenosis would increase the M I	2 and 1/2 months Unchanged

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW UP

Case No. N Y Hospital History No.	*Postoperative Course to Death*	*Cause of Death*	*Time of Death After Operation*	*Autopsy*
Case No 74 I S 644696	Heart failure improved for about a year and a half One year postoperatively acute rheumatic fever thrombophlebitis, left leg, possible pulmonary infarct Episode of fever Tracheobronchitis Two years postoperatively left retinal embolus	Unknown, probably heart failure	2 years, 6 months.	Not obtained.
Case No 92 C P 668518	Right popliteal artery embolus 2 months after operation This caused much pain in foot Patient's internist thought operation helped cardiac status Arterial insufficiency of right foot main problem Admission to mental hospital Possible diabetes insipidus	Probably heart failure	2 years, 3 months	Not obtained.
Case No 96 M B 236453	Continued downhill course	Unknown	1 year 5 months	Not obtained. Died elsewhere.

TABLE 28 (*continued*)

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW-UP

Case No N Y Hospital History No	*Sex Age at Time of Operation*	*Preoperative classification*	*Reason for Operation*	*Preoperative Valvular Diagnosis*	*Valve Size Before Operation*	*Valve Size After Operation*	*Adequacy of Split*	*Valve Calcification*	*Comments on Operation*	*Time of First Follow up and Evaluation*
Case No 98 K M 660118	Male 10	III D	Dyspnea and fatigue	M S M I	1 cm²	3 cm²	Fair	+		3 months Moderately improved

TABLE 28 *(continued)*

DATA ON THE 20 PATIENTS WHO DIED IN THE LONG TERM FOLLOW UP

Case No. N. Y. Hospital History No.	*Postoperative Course to Death*	*Cause of Death*	*Time of Death After Operation*	*Autopsy*
Case No. 98 K. M. 660448	Just before the saddle embolus occurred, patient was about the same as before the operation. Conservative therapy failed to save right leg. Mid-thigh amputation 7 days after embolus. Fairly smooth postoperative course for four days. Then left femoral pulse became weaker. Shock. Death. Pulmonary embolus was clinically suspected	In postoperative course after mid-thigh amputation necessitated by saddle embolus	1 year 5 months	Adherent pericardium. Mitral leaflets greatly thickened and fused and focally calcified. Orifice 2 x 4 mm. slit. Fracture sites visible but fused. Soft papillary vegetations on auricular surface of valve almost obliterating orifice. Right atrium dilated to eight times normal size. Dilated right ventricle, 8 mm. in thickness. Tricuspid leaflets are slightly thickened and retracted. Numerous small beaded pink verrucae on auricular surface of valve especially above the line of closure. Fusion and thickening of chordae and hypertrophy of papillary muscles on both sides of the heart. Fibrosis in all layers of heart, especially in endocardium of left atrium. No Aschoff bodies in multiple sections. Heart weight: 390 gm. Recent thrombosis of the right common right iliac artery, starting 2 cm. within the aorta. Distal end of left femoral artery occluded. Amputation right mid thigh. Focal consolidation of lungs. Marked alveolar septal fibrous thickening. Passive congestion of lungs. Cardiac cirrhosis of liver

We wish to thank the Hospitals we have mentioned for supplying us with these data when patients died out of The New York Hospital.

In only one autopsy was there definite evidence of refusion of the fracture site It is our impression that the most important factor involved in the postoperative narrowing of the mitral orifice is progression of the basic rheumatic process

Six patients were subjected to two valvulotomies and in only one did the surgeon think that refusion had occurred (Case No 256) In this patient the lateral commissure had refused and was reopened for the second time The patient was clinically improved afterward One patient (Case No 9), who had two valvulotomies and died shortly after the second operation, had documented restenosis due to progression of the inflammatory process (Part I, page 50, and Figures 2, 3, 4, 5)

The protocol and autopsy findings of one patient, Case No 278 (E C, N Y Hospital History No 738568) are now presented in detail The surgeon estimated that an adequate surgical split had been obtained but no evidence of the valvulotomy was found when the heart was examined at the time of her death fourteen months postoperatively A photograph of the atrial aspect of this mitral valve is reproduced in Figure 9 This death occurred after this second long term follow up had been closed

The patient was a 58 year old woman who had acute rheumatic fever in early life Six years before operation she suffered subacute bacterial endocarditis due to an alpha hemolytic streptococcus which was cured by the use of penicillin There may have been a splenic infarct at this time A right renal infarct may have occurred ten months before mitral valvulotomy This kidney did not visualize on intravenous pyelography Auricular fibrillation was present Other findings were murmurs of mitral stenosis, mitral insufficiency, and tricuspid insufficiency Ascites, hepatomegaly, and pedal edema were present The electrocardiogram had left axis deviation without electrocardiographic evidence of ventricular hypertrophy The x-ray photograph of the chest showed evidence of enlargement of all four heart chambers

A cholecystectomy had been performed seven years before mitral valvulotomy Five and a half months before valvulotomy a meningioma had been successfully removed The patient also had mild diabetes

The patient was accepted for mitral valvulotomy At operation a left auricular thrombus was washed out Definite mitral insufficiency was found and was unchanged after the mitral valve orifice was increased in size from 1 3 sq cm to between 3 0 and 3.5 sq cm Aschoff bodies were found in the auricular appendage

Several complex cardiac arrhythmias occurred during the post operative period These were successfully treated Normal sinus rhythm was present when the patient was discharged from hospital

She was admitted to hospital three months postoperatively because of increase in congestive failure and an episode of pneumonia Subacute bacterial endocarditis was suspected blood cultures however were negative The diagnosis of a low-grade compensated hemolytic anemia was thought to be the best explanation for hyperbilirubinemia that was found After discharge she continued to manage poorly and remained in severe heart failure requiring a maximal regimen including mercurial injections twice a week When evaluated for this series four months after operation the patient s status was estimated to be unchanged Fourteen months after operation an admission to hospital was necessary to treat intractable anasarca Extensive efforts were made but without much success A paracentesis was performed The patient died quietly in bed on the twenty first hospital day

At autopsy performed fourteen months after the valvulotomy 400 cc of fluid were found in the right pleural cavity and 500 cc in the peritoneal cavity The heart weighed 560 grams There was evidence of the cardiotomy in the left auricle which was moderately dilated There was a thrombus on the anterior wall of the left auricle 2 5 cm across and 0 3 cm in thickness The mitral valve was rigid and thickened at the free margins and fused at the extremities of the commissures Small areas of erosion were found near the free margins There was no definite evidence of the valvulotomy* The chordae were thickened fused and shortened The aortic cusps were slightly fused at the commissures and

*The valve was palpated by the surgeon at the time of the autopsy and it was his opinion that the orifice was still patent (about 2.5 to 3.0 sq cm) but not to an optimal extent

contained firm fibrous nodules averaging 0 5 cm across at the line of closure Many Lambl's excrescences were present on the atrial surface of the mitral valve and the ventricular surface of the aortic valve The tricuspid valve was slightly thickened at the free margin The pulmonic valve was unremarkable There was generalized coronary sclerosis and a grey scar, one centimeter in diameter, was found in the posterior wall of the left ventricle The lumen of the circumflex branch of the left coronary artery beginning 2 cm distal to its ostium was greatly narrowed by an eccentric atheroma Aschoff bodies were present in the myocardium

There was chronic passive hyperemia of the lungs The lobular pattern of the liver was obliterated by fibrous tissue and the liver capsule was nodular and thickened These findings were interpreted as evidence of cardiac cirrhosis

There was an old large infarct of the right kidney It is recalled that the right kidney did not visualize in an intravenous pyelogram before operation An elonged 6 0 by 0 8 cm area of necrosis was found in the under-surface of the right frontal lobe and the right optic nerve was atrophic There was an area of cystic degeneration 1 cm across in the white matter of the right frontal lobe

The autopsy did not disclose the immediate cause of death

Section II

CLINICAL MATERIAL

ESTIMATED STATUS IN LONG TFRM FOLLOW UP OF THE 85 PATIENTS IN THE ORIGINAL ANALYSIS (PART I)

As mentioned in the section on mortality (p 155) 20 of the 85 patients in the original analysis have died making a mortality of 23 6 per cent The present status of the remaining 65 patients is listed in Table 31 Seventy four per cent of these patients remain improved

The criteria for improvement in this long term follow up are the same as in Part I of this monograph (Part I p 17)

Table 32 shows the present status of the original 85 patients compared with their status at the time of the shorter follow up

Twenty-seven of the 35 patients judged to have been markedly improved earlier are still improved as are 16 of the 26 who were judged to have been moderately improved (Table 32) Six of these 26 have improved sufficiently to be classified as markedly improved. Four of the 15 patients who were unchanged at the time of the earlier analysis are now improved but one is worse

TABLE 31

ESTIMATED STATUS AT THE END OF THE LONG TERM FOLLOW UP PERIOD OF THE 65 PATIENTS STILL LIVING (FROM THE ORIGINAL GROUP OF 85 (PART I)

		Per Cent	
Markedly improved	32	49	74 per cent improved
Moderately improved	16	25	
Unchanged	11	17	
Worse	4	6	
Long term follow up not obtained	2	3	
	65 Patients		

TABLE 32

STATUS OF THE 85 PATIENTS AT THE END OF THE PERIOD OF THE LONG TERM FOLLOW-UP COMPARED WITH THEIR STATUS AT THE SHORTER TERM FOLLOW-UP

Status	*Number of Patients in each Category in Short term Follow-up*	*Status with Respect to Improvement of these Patients at End of Long-term Follow-up*								
		2+	1+	0	*Improved → 0*	*Improved → Worse*	*Unchanged → Worse*	*Worse*	*Died*	*No Follow up*
Markedly improved	35	21	3	1	0	0	0	0	6	1
Moderatedly improved	26	6	10	1	0	0	0	1	1	1
Unchanged	15	2	2	1	0	0	0	1	6	0
Improved→Unchanged	3	0	0	1	0	0	0	2	0	0
Improved→Worse	1	0	1	0	0	0	0	0	0	0
Unchanged→Worse	1	0	0	0	0	0	0	0	1	0
Worse	1	0	0	0	0	0	0	0	1	0

and six (40 per cent) have died Inspection of the remaining four categories in Table 32 demonstrates that patients who are worse after the operation invariably die before the end of a long term follow up such as this The one patient in the Improved going over to Worse category is now improved because of a successful second valvulotomy (Part II p 131)

In a few cases a change in status between the two follow ups may have been related to the effects of other diseases as in the case of one patient in whom lymphosarcoma developed Usually however the change in status was related to improvement or deterioration in cardiovascular function

One patient who could not come for follow up in the first analysis and was therefore not included was estimated at this long term analysis to be markedly improved

Two patients were not included in the first analysis because it was not possible from the data to make an accurate estimate At present one of these is thought to be markedly improved the status of the other one has been unchanged by mitral valvulotomy

LONG TERM FOLLOW UP OF PATIENTS WHO HAD EXPLORATORY THORACOTOMY

Four patients fall into this category To recapitulate (Part I p 22) one patient who was classified IVD preoperatively died on the twentieth postoperative day A vestigial auricular appendage had prevented operative entrance into the auricle The remaining three patients were alive at the end of the short term follow up One of these patients has died since then This patient had pre dominant mitral insufficiency without stenosis She died at home two years and nine months postoperatively Another patient was alive but worse four years and five months after operation The left auricle had not been entered because of a calcified clot Only one of the four patients has remained unchanged over a follow up period of almost five years In this patient the auricle could likewise not be entered for technical reasons The pitfalls in evaluating the result of the operation are exemplified in this patient who has remained unchanged for almost five years with out mitral valvulotomy If a valvulotomy had been performed the operation could easily have been given credit for her present status

STATUS OF FIVE PATIENTS WHO HAD MITRAL VALVULOTOMIES DURING PREGNANCY

In this long term follow up three of the 5 patients are estimated to be moderately improved, one unchanged, and one could not be located for follow up To recapitulate (Part I, p 48) all of these patients except the one who was estimated to be unchanged delivered normal full term babies Both of the patients who were moderately improved subsequently each went through another pregnancy without difficulty

The one patient whose status was unchanged after valvulotomy, and delivered a premature baby that died has maintained her status over a follow up period of four years and two months She had had a psychotic episode after the delivery, but made an excellent recovery from this Four years after valvulotomy she suddenly lost sight in her right eye due to occlusion of the right central retinal artery She had experienced premonitory symptoms a few months previously The pathologic basis of this accident was not certain The patient was not placed on anticoagulants A factor that mitigated against the use of anticoagulants was the inability of the patient to come in for adequate control of the prothrombin times

Pregnancy after Valvulotomy (in Patients who were not Pregnant at the Time of Operation). Three patients fall into this category One patient who had had one pregnancy before mitral valvulotomy was found to be eight weeks pregnant one year and ten months postoperatively A spontaneous abortion occurred soon afterward Another patient became worse after an initial improvement following the first valvulotomy, and had a second valvulotomy She was improved thereby She became pregnant six months after the second valvulotomy. Pregnancy was interrupted to avoid the additional burden on the patient's cardio vascular system

The third patient had had heart failure during her first pregnancy and acute pulmonary edema during delivery The valvulotomy was performed two years later It was followed by marked improvement Four years and one month after mitral valvulotomy she delivered a normal baby without any complications This

experience represents the third baby born to a mother who has had a valvulotomy The mother of the first two had been pregnant at the time of operation (Part III p 186)

EFFECT OF MITRAL VALVULOTOMY ON THE OCCURRENCE OF EMBOLI IN PATIENTS WHO HAD HAD PULMONARY EMBOLI PREOPERATIVELY

To recapitulate

1) Twenty two patients had preoperative pulmonary emboli Four of these had arterial emboli at the time of operation One embolus went to the brain one to an eye and two were calcium emboli causing no detectable residual damage Only one of these four patients had further emboli The patient suffering the left eye embolization suffered pulmonary infarction in the immediate postoperative period

2) Four of the 22 patients had pulmonary emboli in the immediate postoperative period None of the four patients had any further embolic episodes

3) Two of the 22 patients had emboli during the first follow up period The patient who suffered one pulmonary emboli at four and another six weeks after operation had no other embolic phenomena The patient who had a hemiplegia six weeks after operation with subsequent recovery died one year and five months postoperatively The cause of death is not known

In the present long term follow up only two additional patients in this group had additional emboli Both were arterial The embolus in one patient was cerebral (in a patient who had had two such episodes preoperatively) causing death one year and one month postoperatively In the other saddle embolus occurred and the patient died after an amputation one year and five months postoperatively Both of these fatal emboli were the first that had occurred since the preoperative emboli

Accordingly there were no additional pulmonary emboli in the long term follow up It appears that mitral valvulotomy decreases the incidence of pulmonary emboli in those patients who had had them before the operation It is also apparent that there is no way to predict which patients will suffer further embolic phenomena

EFFECT OF MITRAL VALVULOTOMY ON THE OCCURRENCE OF EMBOLI IN PATIENTS WHO HAD HAD ARTERIAL EMBOLI PREOPERATIVELY

To recapitulate

1) Two of the 17 patients who had preoperative arterial emboli had arterial emboli at operation Neither patient has had further embolic phenomena

2) Two of these 17 patients had pulmonary emboli in the first postoperative month One of these patients died 23 days after operation The other patient suffered a second pulmonary infarction thirteen months postoperatively

3) The one patient who had a pulmonary embolus in the shorter term follow up had another two years and four months after mitral valvulotomy

In the long term follow up there was only one other embolus in this group, namely, a cerebral one that was fatal This is the same patient discussed under the fate of those who had had preoperative pulmonary emboli, and died 23 days after operation, p 188

It is apparent that the mitral valvulotomy decrease the incidence of arterial emboli

POSTOPERATIVE EMBOLI IN PATIENTS WHO HAD NO PREOPERATIVE EMBOLI

Three patients fall into this category One patient had a pulmonary embolus one month postoperatively and is included in the short term analysis (Part I, p 40) Two other patients had embolic phenomena in the present long term follow up One patient who had lymphosarcoma diagnosed after mitral valvulo tomy had a pulmonary embolus two years and nine months after operation She was estimated to have been unchanged by the operation, although the presence of the malignancy complicated evaluation The third patient in this group was markedly improved as far as her cardiac status was concerned, but had a severe cerebral accident three years and nine months postoperatively An expressive aphasia has slowly responded to speech therapy

ACTIVE RHEUMATIC FEVER AND ARRHYTHMIAS

To recapitulate (Part I p 43)

Three patients were thought to have had acute rheumatic fever all occurring within the first three postoperative months *These patients had classical signs and symptoms of rheumatic* infection Despite the acute rheumatic fever two were markedly and one moderately improved at the time of the long term follow up Three other patients had signs and symptoms suggestive but not diagnostic of acute rheumatic fever Of these three two *were moderately and one was markedly improved*

Three patients had arrhythmias in the long term follow up One had chronic auricular flutter together with other supra ventricular arrhythmias The ventricular rate was difficult to control Another patient has had repeated episodes of auricular flutter often with a very rapid ventricular rate These attacks have occurred only since mitral valvulotomy and were a major reason why the patient was thought to be worse The third patient has had ten readmissions to hospital for paroxysmal auricular fibrilla tion that has been converted on each occasion with small doses of quinidine She is estimated to have been moderately improved

In summary cardiac arrhythmias were not a major problem in the long term follow up

BACTERIAL ENDOCARDITIS IN PATIENTS WHO HAVE HAD MITRAL VALVULOTOMY

Only one patient has had subacute bacterial endocarditis since operation Case No 66 (S.A N Y Hospital History No 652463) who was diagnosed preoperatively as having mitral stenosis mitral insufficiency aortic stenosis aortic insufficiency and tricuspid in sufficiency had a satisfactory split of the lateral commissure at operation He had a pulmonary embolus on the third post operative day but otherwise the postoperative course was un complicated Endocarditis due to streptococcus faecalis was diag nosed six weeks after operation He was treated successfully at another *hospital with penicillin streptomycin and benamid* Eleven months postoperatively his status was estimated to be

unchanged after an initial improvement Approximately 3 years postoperatively he developed severe heart failure At the time of this follow up four years and eleven months after mitral valvulotomy he was thought to be definitely worse than before the operation

THE FIRST 100 PATIENTS WHO UNDERWENT MITRAL VALVULOTOMY CONSIDERED AS A WHOLE, IRRESPECTIVE OF DIVISION INTO GROUPS FOR ANALYSIS

Again to recapitulate, the 100 patients are made up of the large group of 85 who had mitral valvulotomy and survived the immediate postoperative period, together with the five smaller groups adding up to 15 patients Table 33 lists the fate of patients in all groups after an average follow up of 50 months Seventy-five per cent of 100 patients who came to operation are living at the end of the long term follow up period

TABLE 33

STATUS OF THE TOTAL OF 100 PATIENTS IN LONG TERM FOLLOW-UP

Group	*No of Patients Operated*	*No of Patients Still Living*
Original	85	65
Mitral Stenosis Complicated by Pregnancy	5	5
Explored Only	4	2
Operative Deaths	3	0
Inconclusive Evaluation	2	2
Lost to Follow-up	1	1
TOTAL	100	75

Figure 10 shows the attrition rate in patients operated upon during the six and a third years of the study This figure includes patients who had a valvulotomy as well as those who had only an exploratory thoracotomy or cardiotomy Fifty-five per cent of those operated upon in the year 1951 and nine per cent of those

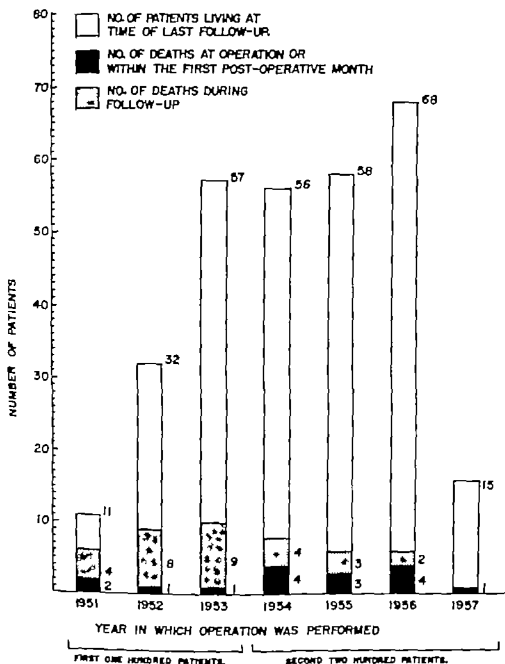


Figure 10 In this figure is shown the status of *all* patients studied in this monograph irrespective of the year of the operation or the group in which the patient's course was analyzed. The operative and follow up mortality is higher in the earlier years as is to be expected because of the longer period of observation

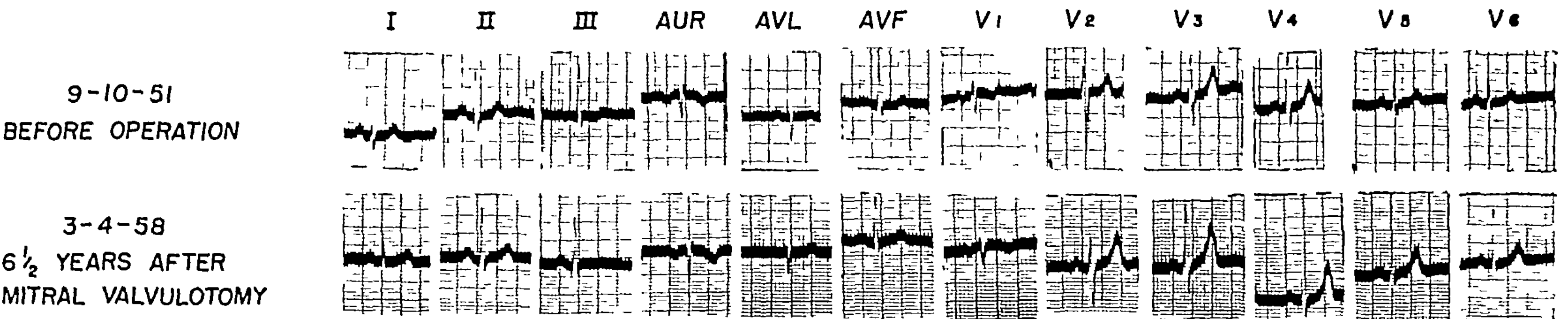


Figure 11 In this figure are shown electrocardiograms of Case No 5 (N F, New York Hospital History No 603356) taken before and six and a half years after mitral valvulotomy See also Figures 12, 13 and 14 This patient's course is discussed in Part III, p 194

operated upon in 1956 (the last full year in the analysis) have died Twenty five of the 100 patients who came to operation in 1951 1952 and 1953 had died by the time of the long term follow up

Included in this analysis are the long term follow up of the first 100 patients and the shorter term follow up of the second and third hundred patients



Figure 12 In this figure is reproduced a preoperative 2 meter x ray photograph of the chest of Case No 5 (N.F New York Hospital History No 603356) See also Figures 11 13 and 14 and Part III p 194

Three patients who were not available for follow up are not included

CASE HISTORIES OF TWO PATIENTS WHO WERE MARKEDLY BENEFITED BY MITRAL VALVULOTOMY, TOGETHER WITH PRE- AND POSTOPERATIVE CATHETERIZATION DATA

Case No 5 (N F, N Y Hospital History No 603356), a 35 year old woman was admitted because of increasing exertional

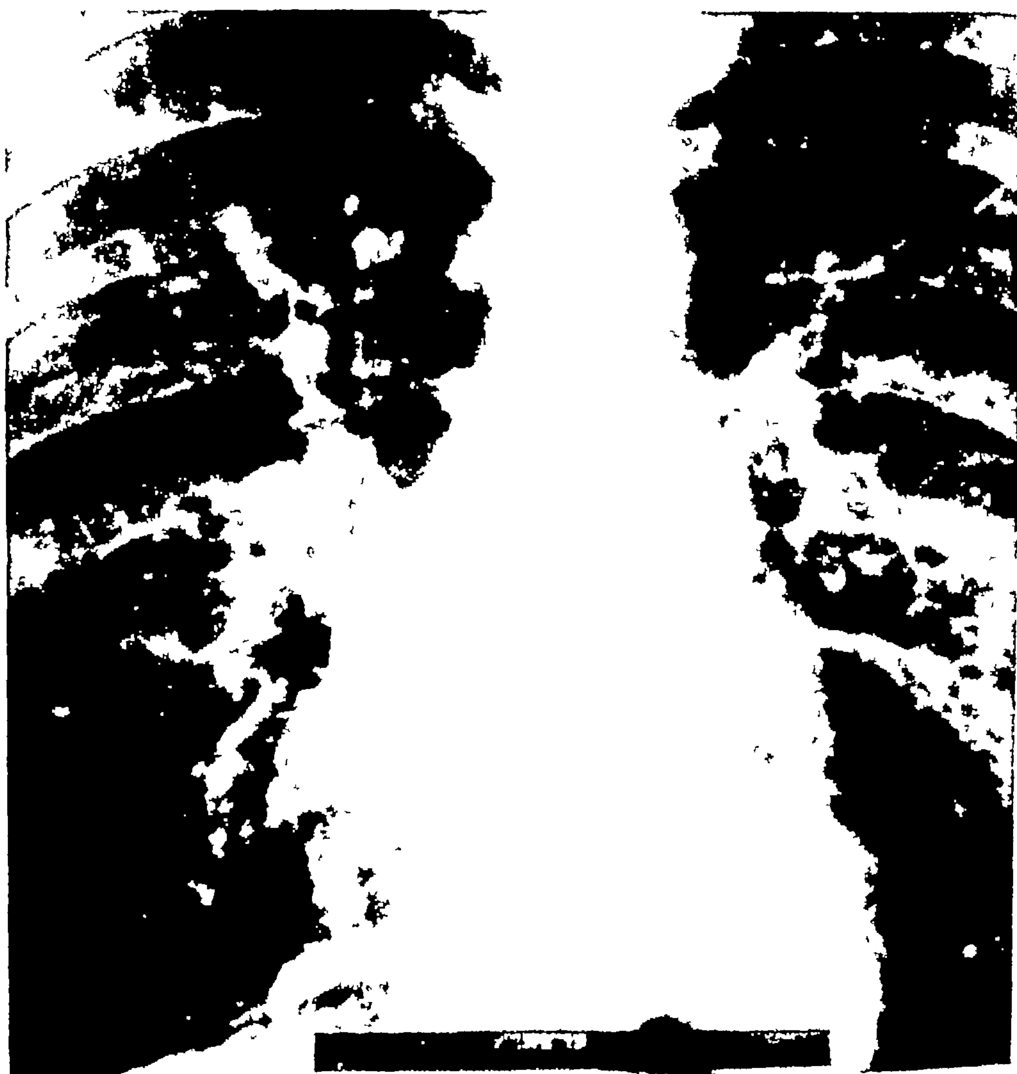


Figure 13 In this figure is reproduced the eight second x ray photograph of an angiocardiogram of Case No 5 (N F New York Hospital History No 603356) demonstrating an opacified, enlarged left auricle The angiocardiogram was performed by Dr Israel Steinberg

dyspnea She could walk only one block or climb one flight of stairs before becoming short of breath She had two pillow orthopnea and she suffered attacks of paroxysmal nocturnal dyspnea The sputum was blood-streaked She was able to do light housework only

On examination the neck veins were not distended The lungs were clear The heart exhibited normal sinus rhythm A presystolic thrill was palpable Long diastolic and presystolic murmurs were heard The blood pressure was 105 68 The liver was not enlarged There was no edema Medication consisted of a low salt diet and digitalis

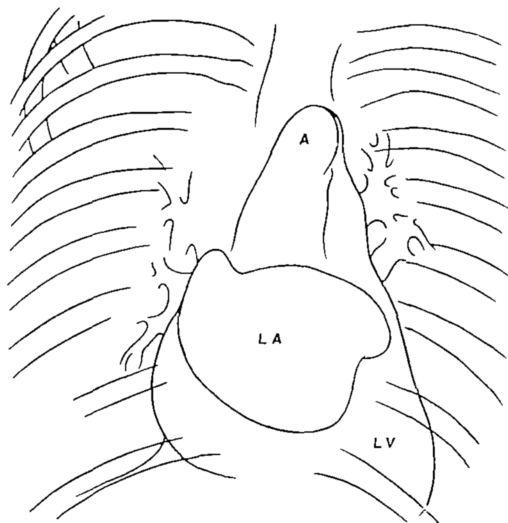


Figure 14 In this figure is reproduced a line drawing of the angiocardiogram shown in Figure 13

The electrocardiogram showed normal sinus rhythm and right axis deviation (Figure 11). The x-ray photograph of the chest demonstrated a slightly enlarged heart, a prominent pulmonary artery segment and hila, a double contour of an enlarged left auricle and a small aortic knob (Figure 12)

The eight second x-ray photograph of the angiocardiogram (Figure 13 and a line drawing in Figure 14) shows opacification of the enlarged left atrium. The dye had first been observed in the left atrium five seconds after injection The left atrium remained well-visualized in all the remaining films, the last film being exposed at ten seconds Other films showed that the left ventricle was small and that the right ventricle and the pulmonary artery were large Catheterization data (June 20, 1951) were consistent with the clinical impression of a tight mitral stenosis (Table 34)

At operation (Sept 13, 1951) clots were not present in the left

TABLE 34

PREOPERATIVE AND POSTOPERATIVE CATHETERIZATION DATA*
*Case No 5 (N F, New York Hospital History No 603 356
Mitral Valvulotomy Performed 9/13/51)*

Measurements	*6/20/51 Before Operation*		*12/14/51 After Operation*	
	Rest	*Exercise*	*Rest*	*Exercise*
O_2 Consumption in cc /min /M²	218	387	130	261
Cardiac output in L /min	4 84	4 96	4 15	6 56
Cardiac Index in L/min /M²	3 08	3 16	2 76	4 07
Pulmonary "Capillary" Pressure	32	45	9	14
Pulmonary Artery Pressure	81/41	101/16	40/13	51/22
Right Ventricle	72/2		12/1	
Right Atrium	−2		1	
Pulmonary Vascular Resistance in dynes/sec /cm⁻⁵	317	500	216	231
Mitral Valve Area in cm²	0 98		2 85	

*We wish to thank Dr Daniel S Lukas for these data

auricle The mitral valve was less than 1 0 cm in diameter It was scarred Calcification was present in a stellate arrangement. A split was readily obtained increasing the estimated valve orifice to 3 0 sq cm On the second postoperative day the rhythm changed to auricular fibrillation and this rhythm persisted until the fifth postoperative day when it spontaneously reverted to normal rhythm One week postoperatively the diastolic murmur of mitral stenosis was not audible The patient was markedly improved after operation

Catheterization data obtained three months postoperatively (Table 34 Dec. 14 1951) showed data which were compatible with her marked clinical improvement Improvement has per sisted during a follow up period of six years and one month At the present time the patient walks many blocks climbs two flights of stairs has no orthopnea does all of her housework and in addition had been going to work full time since the sixth postoperative month A short presystolic rumble has more recently been heard The electrocardiogram (Figure 11) six and a half years after the operation shows the absence of an S wave in Lead I and a less prominent R wave in Lead V_1

Case No 42 (H W N Y Hospital History No 644164) a 47 year old woman was accepted for mitral valvulotomy because of rapid progression of exertional dyspnea with chest pain three pillow orthopnea recurrent hemoptysis and attacks of pulmonary edema. Embolization to the legs had occurred in the past Re covery was excellent She had suffered fourteen episodes of pneumonia over a period of 29 years The preoperative New York Heart Classification was IVD

Auricular fibrillation was present with a moderately slow ven tricular rate The murmurs of mitral stenosis mitral insufficiency and tricuspid insufficiency were heard The blood pressure was 100/70 Râles were heard in the lung fields and there were signs of effusion in the right pleural cavity The liver was enlarged There was no edema Medication consisted of low salt diet digitalis weekly mercurials and resins

The electrocardiogram showed evidence of right ventricular hypertrophy The x ray photograph of the chest (Figure 15 and

line drawing in Figure 16) showed moderate cardiac enlargement with a prominent right ventricular outflow tract. The pulmonary artery was large, the hila were prominent, and in the lateral view the barium-filled esophagus was displaced posteriorly by an enlarged left auricle The right costro-phrenic sulcus was blunted Clinically this was thought to be due to a plueral effusion



Figure 15 In this figure is shown the preoperative 2 meter x ray photograph of the chest of Case No 42 (H W, New York Hospital History No 641164) The bulge of the large left pulmonary artery is shown on the left cardiac border This patient's course is discussed in Part III, p 197

Catheterization data (Dec 9 1952) were consistent with severe mitral stenosis and advanced pulmonary vascular sclerosis (Table 35) There was evidence of mitral and tricuspid insufficiency in the pressure curves The cardiac output fell with exercise Angiocardiogram is shown in Figure 17 and a line drawing in Figure 18 The 21 second preoperative angiocardiogram shows a well filled left atrium a partly opacified left ventricle and an opacified aorta and left pulmonary artery Other x ray photographs in the angio series showed a very large right atrium a large right ventricle a

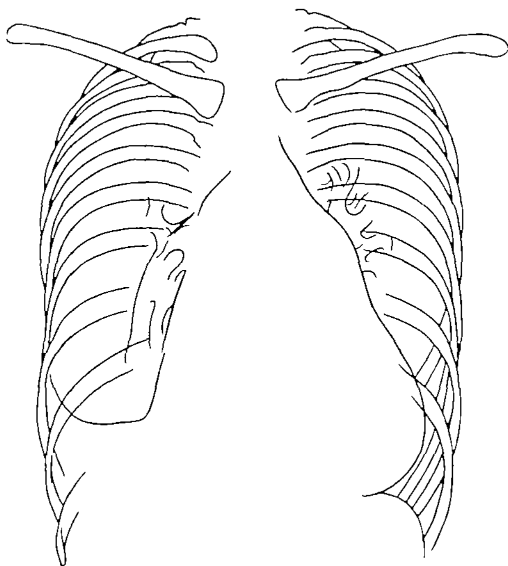


Figure 16 In this figure is shown a line drawing of Figure 15

markedly dilated pulmonary artery and a large left ventricle The circulation time of this patient was prolonged This 21 second x-ray photograph was the last film of the angiocardiogram.

At operation (Dec 16, 1952) a diastolic thrill was palpable over the left ventricle Clots were not encountered in the left auricle The mitral orifice barely admitted the finger tip and its greatest diameter was 0 5 cm A regurgitant jet was palpated in

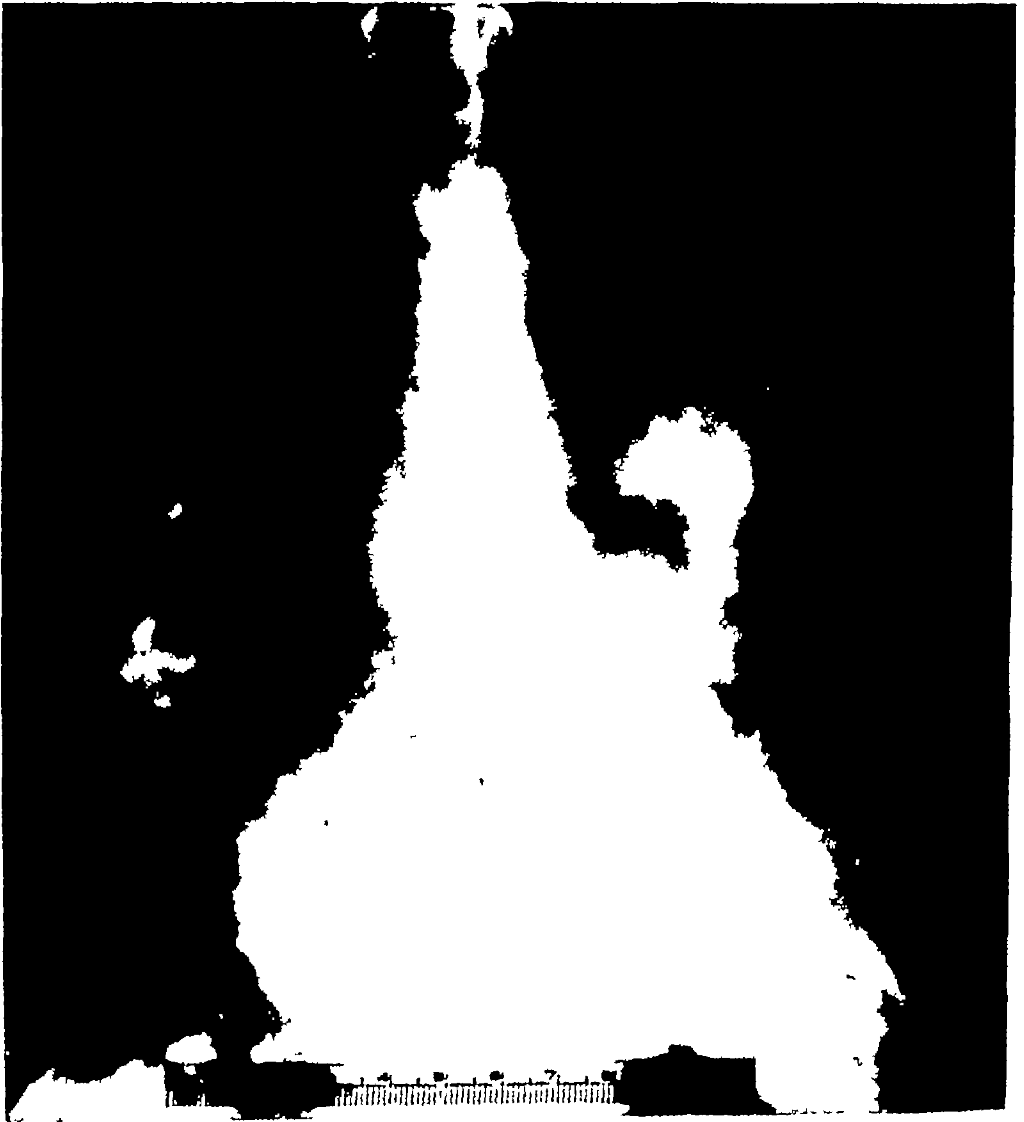


Figure 17 In this figure is reproduced a preoperative angiocardiogram taken at 21 seconds of Case No 12 (H W New York Hospital History No 641164) to show the large left auricle and dilated left pulmonary artery The angiocardiogram was performed by Dr Israel Steinberg

TABLE 33

PREOPERATIVE AND POSTOPERATIVE CATHETERIZATION DATA
Case No 42 (H H New York Hospital History No 614 164)
Mitral Valvulotomy Performed 1/16/5?

Measurements	12/9/5?		3/8/55	
	Before Operation		*After Operation*	
	Rest	*Exercise*	*Rest*	*Exercise*
O_2 Consumption cc./min/M^2	130	230	113	296
Cardiac output in L/min	2.53	2.30	2.60	4.07
Cardiac index in L/min/M^2	1.85	1.68	1.88	2.95
Pulmonary capillary pressure	33	44	[illegible]	13
Pulmonary artery pressure	126/49	1 0 2	30 15	50/31
Right ventricle	124/[illegible]		30 2	
Right atrium	8	21	1	3
Pulmonary vascular resistance in dynes/sec/cm^{-5}	1422	2293	461	511
Mitral valve area in cm^2	0.6		1.8	

We wish to thank Dr Daniel S Lukas for these data

systole The valve was calcified medially and very distorted posteriorly A good split was obtained and the estimated area of the valve was increased to 3 0 sq cm Some degree of regurgitation persisted After the split the diastolic thrill over the left ventricle was no longer palpable Postoperatively the patient did well despite a right lower lobe pneumonia Auricular fibrillation persisted Shortly after operation the patient noted difficulty in reading A left hemianopsia was found and has persisted

The patient experienced marked clinical improvement. Recatheterization data obtained two years and two months postoperatively (March 8 1958) are presented in Table 35 The cardiac output now rose with exercise and the pulmonary capillary pressure was essentially normal X ray photograph of the chest showed the cardiac shadow and the pulmonary artery and its branches to be smaller (Figure 19 and a line drawing in Figure 20)

When seen four years and ten months after operation, the patient was doing all her housework, worked full-time as a librarian, and had recently climbed six flights of stairs She had experienced no orthopnea, hemoptysis, pulmonary edema, nor emboli since operation Murmurs of mitral stenosis and mitral insufficiency were again heard There was clinical evidence of

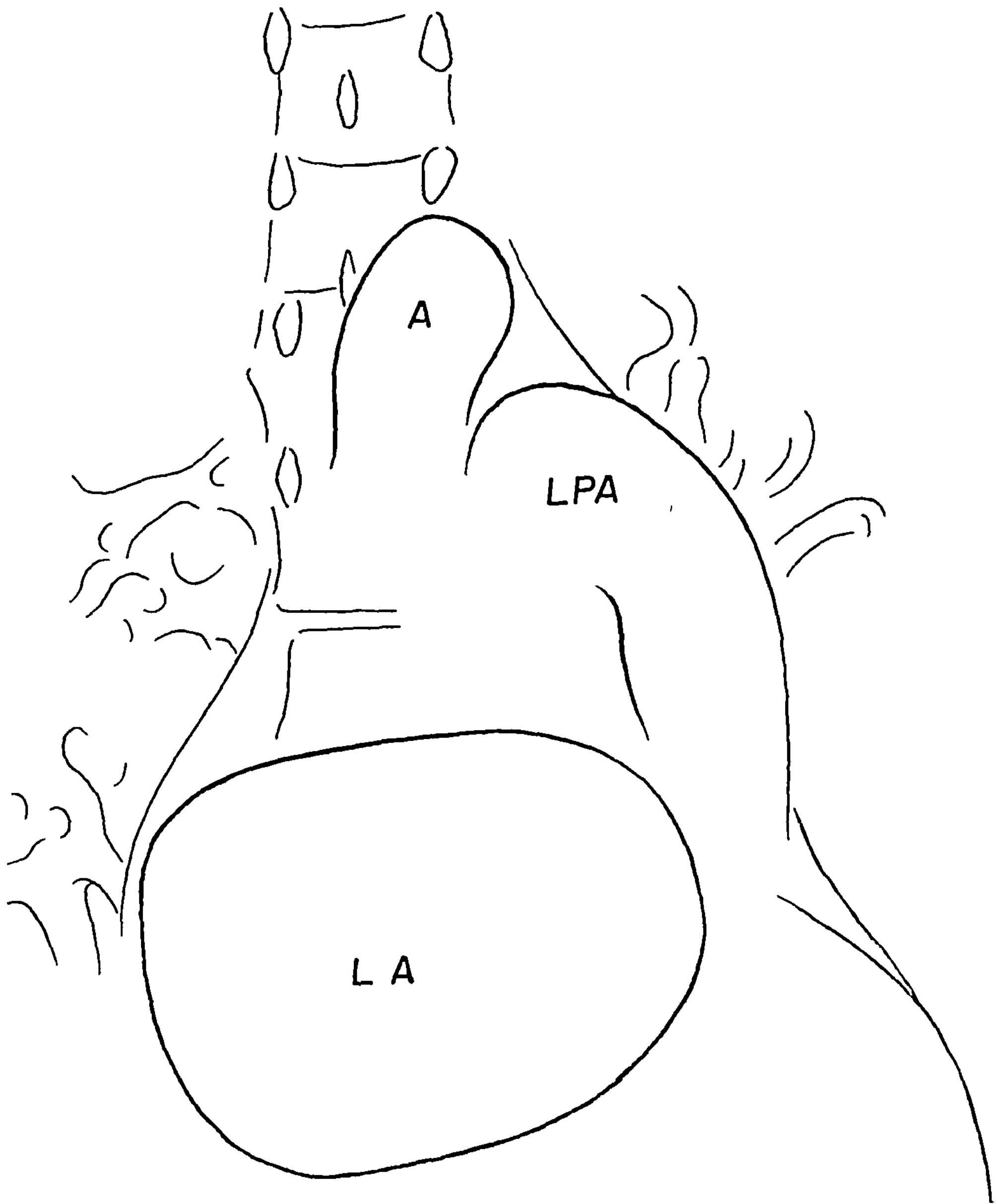


Figure 18 In this figure is reproduced a line drawing of the angiocardiogram shown in Figure 17 L A represents the left auricle and L P A, the left pulmonary artery

tricuspid insufficiency The liver was not enlarged and there was only slight edema of the feet

The operation had resulted in a change of New York Heart Classification from IVD to IIC

Two years and two months after the mitral valvulotomy a cholecystectomy and common duct exploration had been performed for cholelithiasis and common duct stone



Figure 19 In this figure is reproduced a 2 meter x ray photograph of the chest of Case No 42 (H W New York Hospital History No 644164) taken two years and two months after mitral valvulotomy

CASE HISTORY OF A PATIENT WHO HAD A MITRAL VALVULOTOMY FOLLOWED BY A TRICUSPID VALVULOTOMY

Case No 60 (S G , N Y Hospital History No 289189), a 37 year old woman was admitted because of severe exertional dyspnea, orthopnea, marked ankle edema and ascites Positive findings of the physical examination were marked dependent edema and ascites which, together with râles, cleared up during preoperative

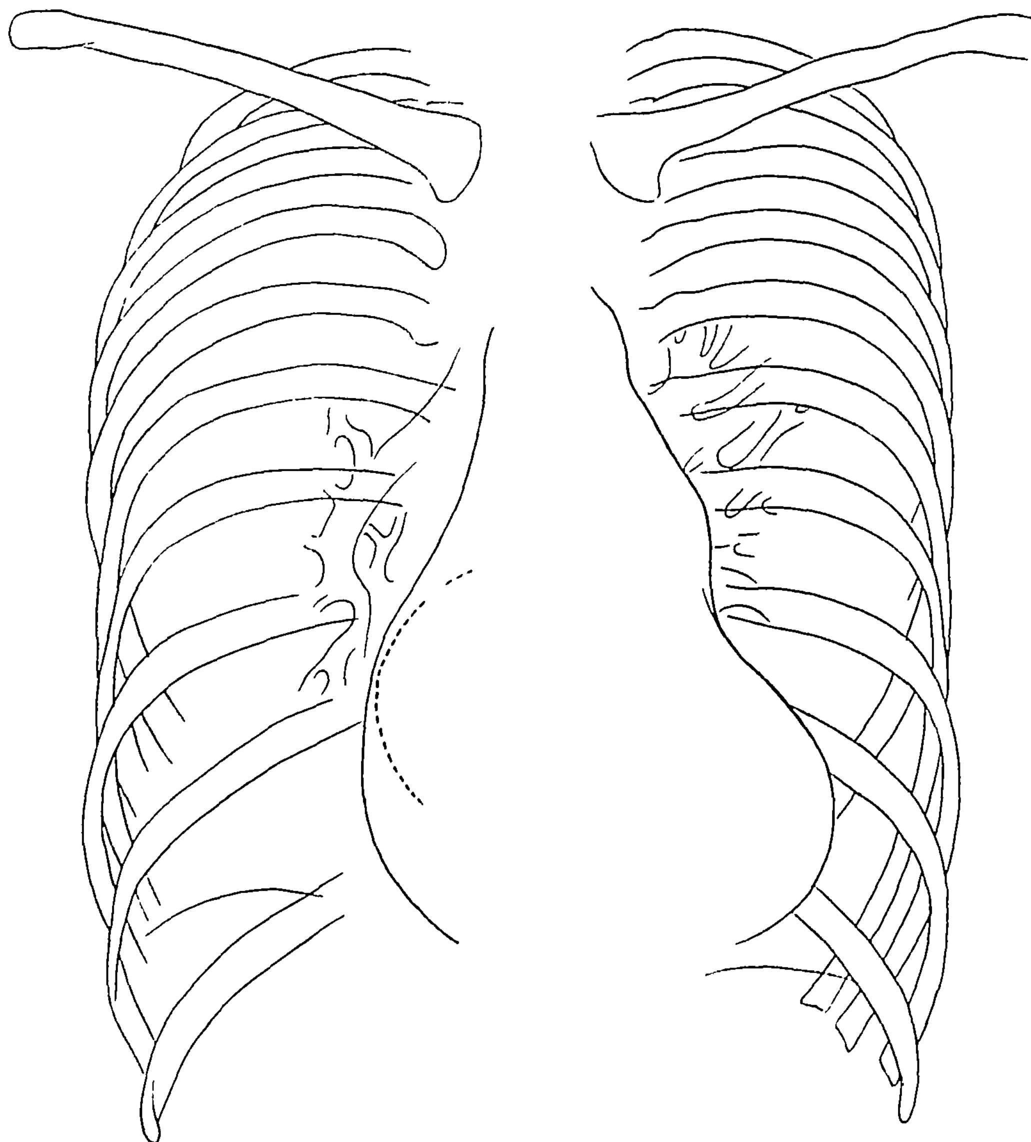


Figure 20 In this figure is shown a line drawing of Figure 19 The calcified left atrial wall is represented by the dotted line

TABLE 36

PREOPERATIVE CATHETERIZATION DATA 3/11/55

(Case No 60 S G., N Y Hospital History No 259 189)
Having Both Mitral Stenosis and Tricuspid Stenosis

	Rest	*Exercise*
O_2 Consumption in cc./min /M²	120	
Cardiac output in L/min	2 74	
Cardiac index in L/min /M²	1.69	
Pulmonary "capillary" pressure	27	32
Pulmonary artery pressure	45/27	50/31
Right ventricle	44/5	50/7
Right atrium	21	29
Pulmonary vascular resistance in dynes /sec./cm⁻⁵	292	
Tricuspid valve area in cm²	0.9	
Mitral valve area in cm²	1 1	
Gradient across tricuspid valve in mm Hg	16	21

We wish to thank Dr Daniel S Lukas for these data

therapy in the hospital The liver was enlarged Auricular fibrillation and murmurs of mitral stenosis and tricuspid stenosis were present. Blood pressure was 120/70 The patient was classified as Class IV E (New York Heart)

Catheterization data confirmed the clinical impression of mitral stenosis and tricuspid stenosis and added the additional diagnosis of mitral and also tricuspid insufficiency (Table 36)

X ray photograph of the chest showed massive enlargement of the heart (Figure 21) The cardiac shadow almost filled the lower half of both thoracic cavities A prominent left atrium was seen There was no evidence of pulmonary congestion This cardiac shadow was the largest in this series There was poor opacification in the angiocardiogram because of the markedly slow circulation time and large size of the cardiac chambers The 25 second x ray photograph is reproduced in Figure 22 and a line drawing in

Figure 23 The right atrium was enormous, extending from close to the right thoracic wall to the left of the spine In the frontal projection its dimensions were 13 by 13 cm The left atrium was

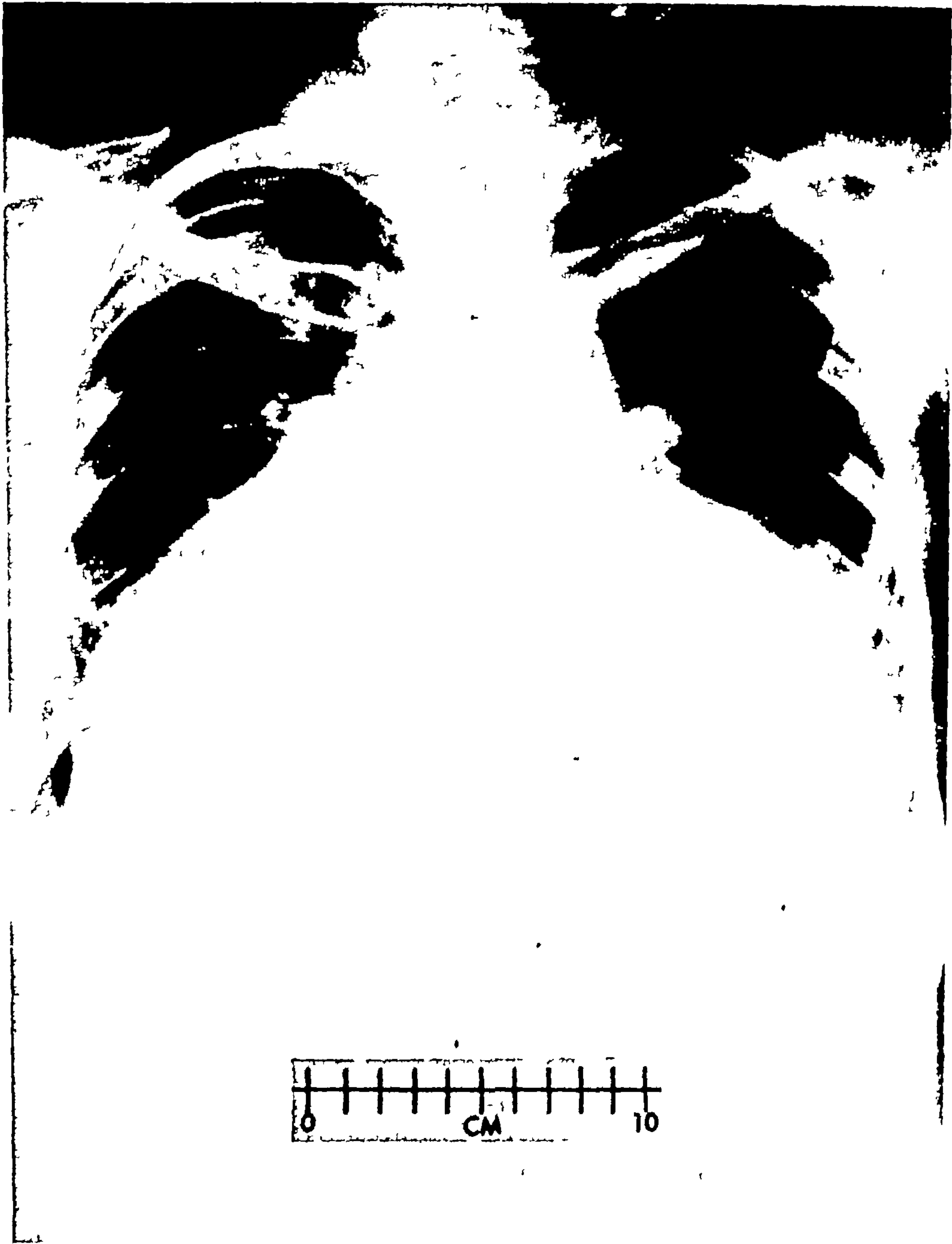


Figure 21 In this figure is reproduced a preoperative 2 meter x-ray photograph of the chest of Case No 60 (S G, New York Hospital History No 289189) See also Figures 22 and 23

three times normal size Adequate visualization of other chambers was not obtained

It was decided to do mitral valvulotomy first At operation a small amount of fluid was aspirated from the left pleural cavity The pericardial sac contained 300 cc of straw-colored fluid A gross diastolic thrill was felt over the right ventricle and a finer



Figure 22. In this figure is reproduced a preoperative angiocardiogram of Case No 60 (S G New York Hospital History No. 289189) taken at 25 seconds. See also Figures 21 and 23 The angiocardiogram was performed by Dr Israel Steinberg

diastolic thrill over the left ventricle The right ventricle was in the right chest and the right auricular appendage could not be visualized through the incision The left auricular appendage was excised and a small clot was found in it No other clots were palpated in the auricle The mitral valve was very stenotic, being 0 4 cm in its greatest diameter There was no regurgitation Excellent splits were obtained both medially and laterally The valve leaflets began to function well No insufficiency was induced The patient's postoperative course was uncomplicated

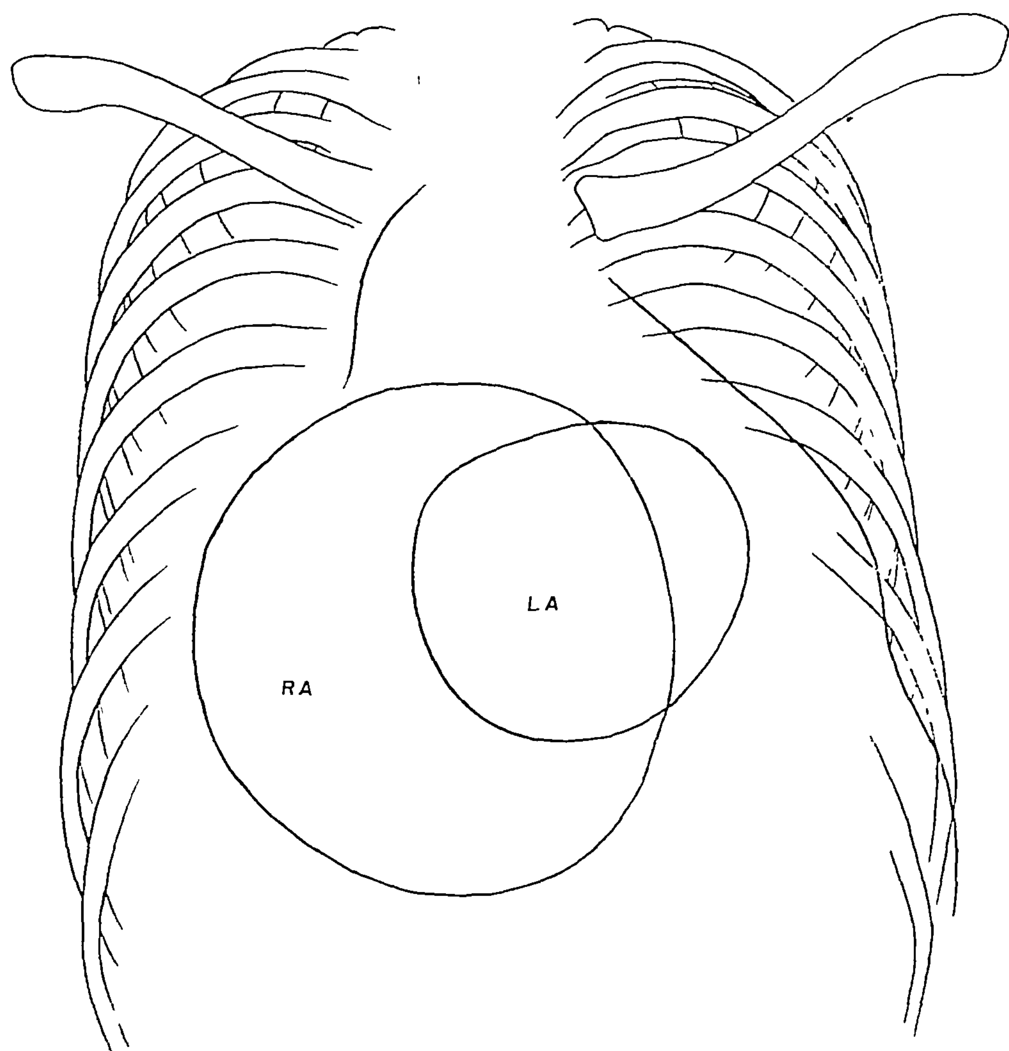


Figure 23 In this figure is shown a line drawing of Figure 22 R A represents the right auricle and L A, the left auricle See also Figures 21 and 22

One month after the mitral valvulotomy the tricuspid valve was approached through the right auricular appendage This appendage was found to be tense and thin One clot was removed from the base of the auricular appendage The tricuspid valve was small and admitted the surgeon s finger tip Tricuspid in sufficiency was present While atempting to go through the valve a split was made laterally for 1 5 cm increasing the regurgitation No further procedure was done on the valve as the stenosis had been relieved The postoperative course was uncomplicated

The patient experienced good clinical improvement. Exertional tolerance increased Fluid accumulation was easily controlled However these problems again recurred about one year and seven months after the tricuspid valvulotomy and have been a problem since Repeated fluid accumulations have necessitated many hospitalizations and diuresis has always been accomplished During a recent admission four years and eight months after the second operation a diuretic regimen resulted in loss of 18 4 kg

Two years and seven months postoperatively a right femoral osteotomy was required because of tuberculous osteomyelitis

COMMENTS ABOUT HEART SIZE IN THE X RAY PHOTOGRAPHS OF THE CHEST

The operative risk of mitral valvulotomy is greater in patients with large hearts especially if significant mitral insufficiency is present Such patients may however be expected to improve if significant *mitral stenosis can be relieved even in the presence* of considerable mitral insufficiency If correction of the stenosis cannot be accomplished the postoperative course is usually very stormy and patients may not recover from the stress of operation

The patient with the largest heart in this series had both mitral stenosis and tricuspid stenosis (Figure 21) Each valvular lesion was relieved at separate operations and the patient was improved

Most of the patients who were accepted for mitral valvulotomy had either slight or moderate cardiac enlargement. Figure 24 shows the preoperative x ray photograph of the chest of Case No 176 (F F N Y Hospital History No 572138) a 25 year old woman who had only slight cardiac enlargement Exertional

dyspnea, fatigue, and paroxysmal nocturnal dyspnea were presenting symptoms The patient had completed a successful pregnancy three years previously, although with an increase in symptomatology At the time of this x-ray photograph of the chest a few days before the valvulotomy, the patient was six months

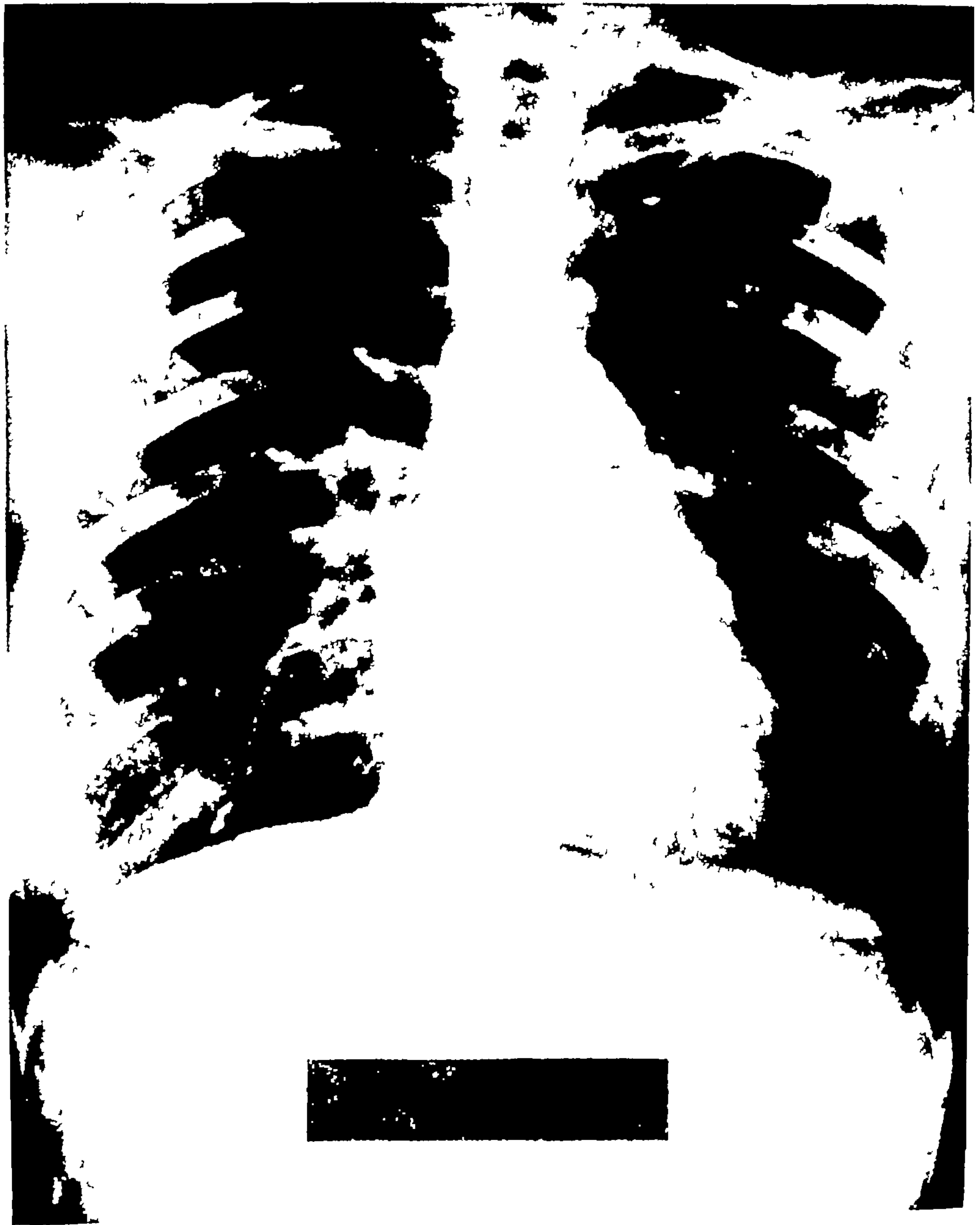


Figure 24 In this figure is reproduced the 2 meter x-ray photograph of the chest of Case No 176 (F F, New York Hospital History No 572138) whose heart shadow was not large

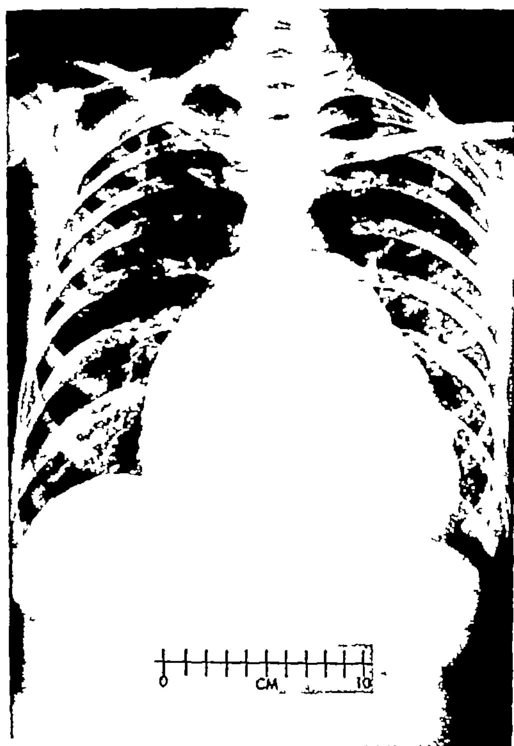


Figure 25 In this figure is shown a 2 meter x ray photograph of the chest of Case No. 112 (T K New York Hospital History No 345948) a patient with moderate cardiac enlargement.

pregnant The clinical diagnosis of pure mitral stenosis was confirmed at operation and a good split was obtained She delivered uneventfully at term The patient was evaluated as having been markedly improved by operation

Figure 25 is the preoperative x-ray photograph of the chest of Case No 112 (T K, N Y Hospital History No 345948), a 41 year old woman who had moderate cardiac enlargement preoperatively She had been accepted for operation because of severe dyspnea and heart failure Auricular fibrillation was present Murmurs of mitral stenosis and tricuspid insufficiency were heard A good split was obtained at operation and the patient was judged markedly improved at follow up two years and ten months postoperatively

Many patients had large cardiac silhouettes in the immediate postoperative period This was usually followed by regression in size

The x-ray photographs of the chest of the first one hundred patients who came to operation were reviewed Only thirty-two of these patients had A-P x-ray photographs of the chest available from the immediate preoperative period and another x-ray at the time of follow up These 32 patients do not represent a homogeneous cross section of the patients because in most cases the films were available only on patients who were improved *

Of the 32 patients whose films were available, 11 had postoperative x-ray photographs available at the shorter term follow up and 21 had them at the longer term follow up The average time of the shorter follow up in nine patients was 12 5 months and 57 7 months in the longer follow up

Thirteen of the 28 patients improved by mitral valvulotomy had increases in A-P heart size at follow up (Table 37) In 7 the heart size was smaller and in 8 it was unchanged Three patients with unchanged clinical status had unchanged heart sizes The one patient who was worse had a larger heart at the time of follow up

* X-ray photographs are discarded after 5 years unless patients have had films in this interval

TABLE 37

COMPARISON OF HEART SIZE BEFORE MITRAL VALVULOTOMY AND AT TIME LAST FOLLOW UP

11 patients in short term *follow-up*	9 were improved	In 2 heart size was smaller at follow up In 3 heart size was larger at follow up In 4 heart size was unchanged at follow up
	2 were unchanged	In both patients heart size was unchanged at follow up
21 patients in long term follow up	19 were improved	In 5 heart size was smaller at follow up In 10 heart size was larger at follow up In 4 heart size was unchanged at follow up
	1 was unchanged	heart size was unchanged at follow up
	1 was worse	heart size was larger at follow up

CASE HISTORY OF A PATIENT WHO DIED IN ACUTE PULMONARY EDEMA WHILE IN HOSPITAL AWAITING MITRAL VALVULOTOMY

Patient T C. (N Y Hospital History No 642617) was a 32 year old colored woman who had undergone two uneventful pregnancies thirteen and eight years before admission Four years prior to admission she first experienced dyspnea and orthopnea One year before admission she was digitalized and given mercurials and at eight months she experienced an attack of pneumonia At two months she was admitted to another hospital because of congestive failure and pain and swelling in multiple joints The patient was then transferred to The New York Hospital for evaluation for mitral valvulotomy

Normal sinus rhythm was present The blood pressure was 100/80 The neck veins were moderately distended The lungs were clear The point of maximal impulse was located in the fifth interspace at the anterior axillary line An apical presystolic thrill was palpable The first mitral and second pulmonic sounds were loud. A rumbling apical diastolic and a high pitched loud apical systolic murmur were heard The latter was transmitted to the left axilla One observer thought there was a systolic murmur at the tricuspid area that was different from the apical one. The liver was palpable five centimeters below the costal

margin There was no peripheral edema The New York Heart Classification was IVE

The electrocardiogram showed evidence of right ventricular hypertrophy X-ray photograph of the chest showed a heart enlarged in all dimensions The aortic knob was small There was pulmonary vascular congestion Anti-streptolysin titer was 100 units, the C-Reactive Protein was 1+

The catheterization data were compatible with advanced mitral stenosis (Table 38) The cardiac output was low and did not rise with exercise The pulmonary vascular resistance, pulmonary capillary pressure, pulmonary artery, right ventricular, and right auricular pressures were high There was evidence of tricuspid insufficiency in the right atrial pressure curves

Five days after admission the patient developed acute pulmonary edema and died

Permission for autopsy was given The heart weighed 360 gm Both atria were dilated The right ventricle was dilated and

TABLE 38

CATHETERIZATION DATA (11/11/52)*

T C, N Y Hospital No 642 617
(32 year old colored female who died 11/16/52 in pulmonary edema suddenly while being prepared to undergo valvulotomy)

	Rest	*Exercise*
O_2 Consumption in cc/min/M^2	119	180
Cardiac output in L/min	1 67	1 68
Cardiac index in L/min	1 15	1 16
Pulmonary "capillary" pressure	25	35
Pulmonary artery pressure	105/47	127/65
Right ventricle	93/21	
Right atrium	19	
Pulmonary vascular resistance in dynes/sec/cm $^{-5}$	2105	2142
Mitral valve area in cm ^{2}	0.5	

*We wish to thank Dr Daniel S Lukas for these data

hypertrophied measuring 8 to 10 mm in thickness The tri cuspid pulmonic and aortic valves were normal The mitral valve showed severe fish mouth stenosis The orifice was slit like and measured 1 0 cm in length The valve leaflets were fused and markedly thickened by fibrous tissue They were calcified in a few places The chordae tendinae were shortened thickened and fused There was no microscopic evidence of active myocarditis The lungs showed chronic passive congestion with pul monary edema There was considerable pulmonary atherosclerosis

It was the consensus that a mitral valvulotomy would have been beneficial to this patient The only cardiac lesion was a tight mitral stenosis

Section III

CONCLUSIONS

1 Valvulotomy for mitral stenosis may be expected to result in improvement in approximately 80 per cent of patients who survive the operation

2 Evaluation of patients for operation is best accomplished by a group of physicians in the various medical disciplines

3 Improvement varies in degree from patient to patient and is dependent upon many factors

4 The mortality rate of 5 to 6 per cent is comparable to that associated with major surgical procedures in other areas of the body

5 Sixty-five of the 85 patients analyzed in Part I were still alive at the end of the period of long term follow up (13 to 79 months) Seventy-four per cent of these were improved

6 Seventy-five of the first 100 patients who were selected for operation were alive at the time of the long term follow up, averaging 50 months (range 13 to 79 months) This includes all patients irrespective of the groups in which they were analyzed

7 Mitral valvulotomy decreases the incidence of pulmonary and arterial emboli in patients who had had them preoperatively

8 One patient had bacterial endocarditis after operation

9 The success or failure of mitral valvulotomy should be evaluated on the basis of the relief of symptoms, the correction of disability, and the extension of the life span beyond that to be expected without valvulotomy

Section IV

PRESENT TRENDS IN THE SURGICAL TREATMENT OF MITRAL STENOSIS

As the experience with the surgical treatment of mitral stenosis is extended the importance of diagnostic information and pre operative evaluation in patients with aortic involvement and mitral insufficiency becomes increasingly evident Advancements in cardiac catheterization angiocardiography and circulation studies are contributing to this end For example left heart catheterization now readily accomplished provides more information as to the degree of stenosis and the extent of insufficiency of the aortic and mitral valves than the original right heart approach This type of information correlated with accumulated clinical experience and postmortem observations enables us to delineate the problems of the individual patient and to view the anticipated operative procedure in proper perspective

The surgical treatment of pure mitral stenosis in a patient in the earlier decades is relatively simple However when besides mitral stenosis there is evidence of insufficiency of the same valve or this lesion co-exists with stenosis or insufficiency of the aortic valve and may be further complicated by the patient being over 60 years of age many additional problems confront the surgeon The recognition of these has prompted remarkable attempts to solve them Rapid progress has been made and *in direct* procedures when ineffectual are being replaced by *direct* approaches

Thus with the heart brought into elective standstill and with its work taken over by an extracorporal mechanism the valve is exposed under direct vision and its deformity corrected These approaches require many facilities complicated equipment and highly trained personnel The mere fact that they have become available denotes epoch making progress that has taken place

within this decade Since 1951 we have operated upon over 400 patients for mitral stenosis The first 300 of these have been considered in the previous pages It is anticipated that the trend to employ open heart surgical techniques will continue and that simplification of the present burdensome procedures will result in greater clinical improvement with minimal risk

BIBLIOGRAPHY

Abelmann W H Ellis, L. B and Harken D E The diagnosis of mitral regurgitation An evaluation of clinical criteria, fluoroscopy phonocardiogram auricular esophagogram and electrokymogram. *Am J Med 15* 5 1953

Actis Dato A. Angelino P F and Brusca A. An angiopulmographic study of the lesser circulation in mitral stenosis *Am Heart J 52* 1 1956

Andreassen R and Jensen N K Bacterial endocarditis following mitral valvotomy *Ann Int Med 45* 534 1956

Angelino P F Levi V Brusca A and Actis Dato A Mitral commissurotomy in the younger age group *Am Heart J 51* 916 1956

Araujo J and Lukas, D S Interrelationships among pulmonary "capillary pressure, blood flow and valve size in mitral stenosis The limited regulatory effects of pulmonary vascular resistance *J Clin Investigation 31* 1082 1952

Artusio J F Ether analgesia during major surgery *J.A.M.A ,157* 33 1955

Bailey C. P The surgical treatment of mitral stenosis (mitral commissurotomy) *Dis Chest 15* 377 1949

Bailey C. P and Bolton H E Criteria for and results of surgery for mitral stenosis Part I *New York State J Med 56* 649 1956

Bailey C. P and Bolton H E Criteria for and results of surgery for mitral stenosis Part II *New York State J Med 56* 825 1956

Bailey C. P Glover R P and O Neill T J E The surgery of mitral stenosis. *J Thor Surg 19* 16 1950

Baker C. Brock, R C Campbell M and Wood P Valvulotomy for mitral stenosis. *Brit Med J 1* 1043 1952

Bayer O., Loogen F and Wolter H H The mitral opening snap in the quantitative diagnosis of mitral stenosis. *Am Heart J 51* 234 1956

Bellville, J W, Artusio, J F, and Glenn, F The electroencephalogram in cardiac arrest *J A M A , 157* 508, 1955

Bellville, J W, Artusio, J F, and Glenn, F The electroencephalogram during cardiac manipulation *Surgery, 38* 259, 1955

Bercu, B A A postoperative syndrome following mitral valvuloplasty *J Lab & Clin Med , 42* 783, 1953

Bjork, V O , Malmstrom, G , and Oggla, L G Left auricular pressure measurements in man *Ann Surg , 138* 718, 1953

Black, H and Harken, D E Current indications for the surgical correction of mitral stenosis *Am Heart J , 53* 439, 1957

Bolton, H E , Maniglia, R , and Massey, F C Calcific emboli complicating mitral valve commissurotomy *J Thor Surg , 24* 502, 1952

Braudo, J L , Javett, S N , Adler, D I , and Kessel, I Isolated congenital mitral stenosis *Circulation, 15* 358, 1957

Brock, R C Valvulotomy in pregnancy. *Proc Royal Soc Med , 45* 538, 1952

Bruce, R A , Merendino, K A , Pampush, J J , Bergy, G G , and Brock, L L Functional evaluation of mitral valvulotomy *Am J Med , 20* 745, 1956

Bruce, R A and Rodgers, D L . Quantitative effects of medical and surgical treatment of mitral stenosis on exercise tolerance *Am J Med , 15* 35, 1953

Burchell, H B and Edwards, J E Rheumatic mitral insufficiency *Circulation, 7* 747, 1953

Burchell, H B , Wood, E H , Sutterer, W , Swan, H J C , Helmholz, H F , Crowley, W P , Parkin, T W , Wright, J L , Toscano-Barboza, E , Brandenburg, R O , Fox, I J , Wakai, C S , Connolly, D C , Wood, E H , Keys, J R , Kirklin, J W , and Ellis, F H , Jr Symposium on the diagnostic value of simultaneous catheterization of the aorta and the right and left side of the heart *Proc Staff Meet Mayo Clinic, 31* 105, 1956

Burwell, C S and Ramsay, L H Surgery of the mitral valve and the management of mitral stenosis in pregnant women *Tr A Am Physicians, 66* 303, 1953

Clinico-Pathologic Conference Disproportionate dyspnea in recurrent cardiac insufficiency *Am J Med 23* 142 1957

Conn, H L Jr., Heiman D F Blakemore W S Kuo P T and Langfeld, S B Left heart radiopotassium dilution curves in patients with rheumatic mitral valvular disease *Circulation 15* 582, 1957

Cornell Conference on Therapy Surgical treatment of mitral valvular disease. *Am J Med 18* 326 1955

Contro S Ventricular gallop in mitral stenosis Its mechanism and significance. *Am Heart J 54* 246 1957

Cooley D A. and Chapman D W Mitral commissurotomy during pregnancy *J.A.M.A 150* 1113 1952

Cooley D A. and DeBakey M E. Surgical treatment of mitral and aortic stenosis. *J.A.M.A 155* 235 1954

Criteria Committee of the New York Heart Assoc. Nomenclature and Criteria for diagnosis of diseases of the heart and blood vessels. New York Heart Assoc. 1953

Cutler E. C and Beck, C. S The present status of surgical procedures in chronic valvular disease of the heart Final report of all surgical cases. *Arch Surg 18* 403 1929

Cutler E. C. Levine, S A and Beck C. S The surgical treatment of mitral stenosis Experimental and clinical studies. *Arch Surg 9* 689 1924

Decker J P Hawn C. Van Z and Robbins, S L. Rheumatic activity" as judged by the presence of Aschoff bodies in auricular appendages of patients with mitral stenosis I Anatomic aspects. *Circulation 8* 161 1953

Denton C., Pappas, E. G Uricchio J F., Goldberg, H and Likoff W Bacterial endocarditis following cardiac surgery *Circulation 15*:525 1957

Donoso E., Jick, S Braunwald, E. Lamelas M and Grishman A The spatial vectorcardiogram in mitral valve disease. *Am Heart J 53* 760 1957

Dresdale, D T, Ripstein, C B, Guzman, S V, and Greene, M A. Evaluation of cortisone and ACTH as prophylactic and therapeutic agents in postcardiotomy syndrome in patients with rheumatic heart disease *Circulation, 12* 696, 1955

Dresdale, D T, Ripstein, C B, Guzman, S V, and Greene, M A Postcardiotomy syndrome in patients with rheumatic heart disease Cortisone as a prophylactic and therapeutic agent *Am J Med, 21* 57, 1956

Eliasch, H The pulmonary circulation at rest and on effort in mitral stenosis *Scandinav J Clin & Lab Invest, 4* 1, (suppl 4) 1952

Ellis, L B, Abelmann, W H, and Harken, D E Selection of patients for mitral and aortic valvuloplasty *Circulation, 15* 924, 1957

Ellis, L B and Harken, D E The clinical results in the first five hundred patients with mitral stenosis undergoing valvuloplasty *Circulation, 11* 637, 1955

Elster, S K, Wood, H F, and Sealy, R D Clinical and laboratory manifestations of the post-commissurotomy syndrome *Am J Med, 17* 826, 1954

Ferrer, M I, Harvey, R M, Wylie, R H, Himmelstein, A, Lambert, A, Kuschner, M, Cournand, A, and Richards, D W Circulatory effects of mitral commissurotomy with particular reference to selection of patients for surgery *Circulation, 12* 7, 1955

Fisher, D L The use of pressure recordings obtained at transthoracic left heart catheterization in the diagnosis of valvular heart disease *J Thor Surg, 30* 379, 1955

Geckeler, G D Auscultatory diagnosis of valvular heart disease *Circulation, 13* 608, 1956

Gil, J R, Rodriguez, H, and Ibarra, J J Incidence of asymptomatic, active rheumatic cardiac lesions in patients submitted to mitral commissurotomy and the effect of cortisone on these lesions Clinical and histopathologic study of sixty cases *Am Heart J, 50* 912, 1955

Glenn, F Commissurotomy in mitral stenosis *Rocky Mountain Med. J., 53* 897, 1956

Glenn F Indications and contraindications for surgical treatment of mitral stenosis. *Ann Surg* *141*·686 1955

Glenn, F Mitral stenosis. Practitioners Conference *New York Med* *12*·936 1956

Glenn F The surgery of acquired heart disease *Bull New York Acad Med* *33*·525 1957

Glenn F and Dineen P Recurrent mitral stenosis. A case report *Ann Surg* *143*·405 1956

Glenn, F and Redo S F Mitral stenosis and gallstones *Ann Surg* *147* 817 1958

Glenn F and Stewart, H J Mitral commissurotomy *Bull New York Acad Med* *29*·677 1953

Glenn W W Mitral valvulotomy I The technic with particular reference to the use of a thimble valvulotome *Ann Surg* *145*·557 1957

Glover R P The technique of mitral commissurotomy Presented at the cardiovascular symposium Henry Ford Hospital Detroit, Mich. March 17 19 1955 *Cardiovascular Surgery* Philadelphia Saunders, 1955 p 179

Glover R P and Davila J C Surgical treatment of mitral insufficiency by total circumferential purse string suture of the mitral ring *Circulation* *15*·661 1957

Glover R. P Davila J C O'Neill T J E and Janton O H Does mitral stenosis recur after commissurotomy? *Circulation* *11* 14 1955

Glover R. P., Iaia B D O Neill T J E and Janton O H Thromboembolic data in mitral stenosis before and after surgery *Proc Conf International Congress on Thrombosis and Embolism* Basel Switzerland 1954 Basel Schwabe 1955

Glover R. P., McDowell D E. O Neill T J E. and Janton O H Mitral commissurotomy in relation to pregnancy *J.A.M.A* *158* 895 1955

Glover R. P., O'Neill, T J E and Bailey C. P Commissurotomy for mitral stenosis. *Circulation* *1* 329 1950

Janton O H Brunner R. A. O Neill T J E and Glover R. P Amaurosis following mitral commissurotomy *Am Heart J* *50* 948 1955

Janton, O H Davila, J C. and Glover R. P Status of fifty patients four and a half to seven years after mitral commissurotomy *Circulation* *14* 175 1956

Janton O H Glover R. P., and O Neill T J E Mitral commissurotomy in the older aged patient (an analysis of twenty patients over the age of fifty) *Circulation* *8* 321 1953

Janton, O H Glover R P., O Neill T J E. Gregory J E. and Froio G F Results of the surgical treatment for mitral stenosis (analysis of one hundred consecutive cases) *Circulation* *6* 321 1952

Judson W E Hatcher J D Hollander W., and Halperin M H The effects of mitral valvuloplasty on cardiovascular and renal function at rest and during exercise *J Clin Invest* *34* 1297 1955

Keyes, J W and Lam C. R Recurrence of mitral stenosis following commissurotomy *J.A.M.A* *155* 247 1954

Killip T III and Lukas, D S Tricuspid stenosis *Circulation* *16* 3 1957

Kuschner M Ferrer M I., Harvey R. M and Wylie R H Rheumatic carditis in surgically removed auricular appendages. *Am Heart J* *43* 286 1952

Larson D L. Relation of the postcommissurotomy syndrome to the rheumatic state. *Circulation* *15* 203 1957

Lasser R. P and Amram S S Distensibility of the pulmonary arterial vessels at rest and during exercise in patients with mitral stenosis. *Am Heart J* *51* 749 1956

Lehman J S and Curry J L. A correlation of roentgen and surgical findings in two hundred cases of rheumatic mitral valvular disease *Am J Roentgenol* *71* 599 1954

Lewis, B M., Gorlin R Houssay H E. J Haynes, F W and Dexter L. Clinical and physiological correlations in patients with mitral stenosis *Am Heart J* *43* 2 1952

Logan, G A, Bruce, R A, Bergy, G G, and Merendino, K A Disability two to five years after mitral commissurotomy An evaluation by clinical criteria and exercise tolerance *Ann Int Med*, *47* 248, 1957

Lukas, D S The relation of cardiac catheterization to cardiovascular surgery *Bull New York Acad Med*, *29* 668, 1953

Lukas, D S and Dotter, C T Modifications of the pulmonary circulation in mitral stenosis *Am J Med*, *12* 639, 1952

Lukas, D S, Mahrer, P R, and Steinberg, I Angiocardiographic and physiologic correlations in mitral stenosis *Circulation*, *17* 567, 1958

McKusick, V A Rheumatic restenosis of mitral valve Report of a case with death almost five years after mitral valvulotomy *Arch Int Med*, *95* 557, 1955

McNeely, W F, Ellis, L E, and Harken, D E Rheumatic "activity" as judged by the presence of Aschoff bodies in auricular appendages of patients with mitral stenosis II Clinical aspects *Circulation*, *8* 337, 1953

Manchester, B, Scotti, T M, Reynolds, M L, and Dawson, W H Aschoff bodies in left auricular appendages of patients with mitral stenosis *Arch Int Med*, *95* 231, 1955

Mason, G Discussion of cardiac disease in pregnancy *J Obst and Gynaec Brit Emp*, *59* 569, 1952

Mendelson, C L Heart disease in pregnancy *Surg Clin North America*, Apr 1957, p 321

Mendelson, C L Supportive care, interruption of pregnancy, and mitral valvulotomy in the management of mitral stenosis complicating pregnancy *Am J Obst & Gynec*, *69* 1233, 1955

Moscovitz, H L, Gordon, A J, Braunwald, E, Amram, S S, Sapin, S O, Lasser, R P, Himmelstein, A, and Ravitch, M M The use of simultaneous left heart pressure pulse measurements in evaluating the effects of mitral valve surgery *Am J Med*, *18* 406, 1955

Moscovitz, H L and Wilder, R J The pressure events of the cardiac cycle in the dog mitral valve lesions *Am Heart J*, *53* 741, 1957

Muehsam, G E. and Auerbach O Restenosis of the mitral valve *Ann Int Med 46* 1177 1957

Munnell E. R and Lam C. R. Cardiodynamic effects of mitral commissurotomy *Circulation 4* 321 1951

Musser B G Bougas, J and Goldberg H Left heart catheterization II With particular reference to mitral and aortic valvular disease *Am Heart J 52* 567 1956

Neptune, W B and Bailey C. P Mitral commissurotomy through the right thoracic approach. *J Thor Surg 28* 15 1954

Nichols, H T Likoff W., Goldberg H and Fuchs, M The genesis of the "presystolic murmur in mitral stenosis. *Am Heart J 52* 379 1956

Nordenstrom B., Stamer J P., Jr., Figley M and Sloan H Selective roentgenographic contrast examination and electrokymography of the left heart in experimental mitral insufficiency *Circulation 15* 682 1957

Olesen K H *Mitral Stenosis A follow-up of 351 patients* Copenhagen Ejnar Munkgaards Forlag 1955 p 228

O'Neal, R. M Thomas, W A Lee K T and Rabin E R Alveolar walls in mitral stenosis *Circulation 15*·65 1957

O'Sullivan W D Roseman D M Lovell G R and Glenn F Tricuspid and mitral commissurotomy A case report. *Ann Surg 142* 101 1955

Otto J F., Hutcheson J M Abelmann W H Harken D E Gray J E. and Ellis L. B Clinical observations before and after mitral valvuloplasty Physical radiologic, and electrocardiographic changes *New England J Med 253*·995 1955

Pampush, J J and Bruce R. A Natural history functional capacity and exercise tolerance of unoperated patients with mitral stenosis. *Am J M Sc 228*·605 1954

Parkinson T Pregnancy complicated by mitral stenosis and pulmonary tuberculosis treated by mitral valvotomy *Proc Royal Soc Med 46*·48 1953

Pryor, W W, Hickam, J B, Sieker, H O, and Page, E B Effect of circulatory changes on the pulmonary compliance of normal subjects and patients with mitral stenosis *Circulation, 15* 721, 1957

Rapaport, E, Kuida, H, Haynes, F W, and Dexter, L · The pulmonary blood volume in mitral stenosis *J Clin Invest, 35* 1393, 1956

Read, J. L, Porter, R R, and Bradford, S C Coronary blood flow and myocardial carbohydrate metabolism in mitral stenosis *Am J Med, 19* 150, 1955

Reale, A, Goldberg, H, Likoff, W., and Denton, C Rheumatic tricuspid stenosis A clinical and physiologic study with a suggested method of diagnosis *Am J Med, 21* 47, 1956

Riley, R L, Johns, C J, Cohen, J E, Cohn, D G, Carroll, D C, and Shepard, R H The diffusing capacity of the lungs in patients with mitral stenosis studied postoperatively *J Clin Invest, 35* 1008, 1956

Rumel, W R Mentioned by Massey, F C Heart disease as a complicating factor in pregnancy *Am J Obst and Gynec, 64* 607, 1952

Rusted, I E Scheifley, C H, and Edwards, J E Studies of the mitral valve II Certain anatomic features of the mitral valve and associated structures in mitral stenosis *Circulation, 14* 398, 1956

Saxton, G A, Jr, Rabinowitz, M, Dexter, L, and Haynes, F The relationship of pulmonary compliance to pulmonary vascular pressures in patients with heart disease *J Clin Invest, 35* 611, 1955

Schilder, D P and Harvey, W P Confusion of tricuspid incompetence with mitral insufficiency — a pitfall in the selection of patients for mitral surgery *Am. Heart J, 54* 352, 1957

Schwedel, J. B, Escher, D W, Aaron, R S, and Young, D The roentgenologic diagnosis of pulmonary hypertension in mitral stenosis *Am Heart J, 53* 163, 1957

Scott, R C, Kaplan, S, and Stiles, W. J Observations on the effect of tetraethylammonium chloride on the pulmonary vascular resistance in mitral stenosis *Am Heart J, 50* 720, 1955

Sepulveda, G and Lukas, D S The diagnosis of tricuspid insufficiency *Circulation 11* 552, 1955

Shafiroff, B G P and Kau Q Y Evaluation of physiologic functions after mitral commissurotomy *New York State J Med 57* 1062, 1957

Smith P W., Cregg, H A. and Klassen K. P Diagnosis of mitral regurgitation by cardioangiography *Circulation 14* 847 1956

Smithy H G An approach to the surgical treatment of chronic valvular disease of the heart. XVI Annual Ass n. of the South eastern Surgical Congress. April 5-8 1948 Hollywood Florida

Smithy H G Boone J A. and Stallworth J M Surgical treatment of constrictive valvular disease of the heart *Surg Gynec and Obst 90* 175 1950

Soloff L. and Zatuchni J Some difficulties in evaluating functional results after mitral commissurotomy *J.A.M.A 154* 673 1954

Soloff L. A. and Zatuchni J The relationship of displacement of the esophagus to left atrial volume and heart size in persons with mitral stenosis. *Am J Med 21* 551 1956

Soloff L. A. Zatuchni J and Fisher H Use of planigraphy in demonstration of calcification of heart valves and its significance *Arch Int Med 95* 219 1955

Soloff, L. A Zatuchni J Janton O H O Neill T J E and Glover R. P Reactivation of rheumatic fever following mitral commissurotomy *Circulation 8* 481 1953

Soloff L. A., Zatuchni J and Mark G E Jr Relationship of left atrial volume to pulmonary artery and wedge pressures in mitral stenosis. *Circulation 15* 430 1957

Soloff L. A Zatuchni J Stauffer H M and Kelly E W Angiocardiographic observations of intracardiac flow in the normal and in mitral stenosis. *Circulation 13* 334 1956

Somerville, W Cardiac disease in pregnancy *Lancet 2* 179 1952

Soulie, P., DiMatteo J and Azerad J Resultats de la commissurotomie pour retrecissement mitral (a propos de 213 interventions) *Bull et mem Soc med hop 71* 742 1955

Soutar H S The surgical treatment of mitral stenosis *Brit Med J 2* 603 1925

Steinzeig, S M . Pinsky, S T , Alimurung, M , and Dimond, E G · Phonocardiographic changes in mitral stenosis before and after valvulotomy A correlation with mitral valve size *Am Heart J*, *53* 735, 1957

Stollerman, G H , Lynch, W F , Dolan, M A , Young, D , and Schwedel, J B . Immunologic evidence of group A streptococcal infection in patients undergoing mitral commissurotomy *Circulation, 15* 267, 1957

Thomas, W A , Averill, J H , Castleman, B , and Bland, E F The significance of Aschoff bodies in the left atrial appendage *New England J Med , 249* 761, 1953

Thorbjarnarson, B and Glenn, F Scarcoidosis associated with sudden death during mitral valvulotomy *Arch Surg , 73* 862, 1956

Tropea, F and Entine, J Peripheral embolization following mitral commissurotomy *Arch Surg , 67* 43, 1953

Wallyn, R , Dillon, R , and Brofman, B L Pulmonary resectional surgery in mitral stenosis *Am Heart J , 51* 98, 1956

Watt, G L , Bigelow, W G , and Greenwood, W F A surgical approach to the treatment of mitral stenosis in pregnancy *Am J Obst & Gynec 67* 275, 1954

Werko, L , Bergstrom, J , Bucht, H , Ek, J , Eliasch, H , Eriksson, K , Thomasson, B and Varnauskas, E Studies on the renal circulation and the renal function in mitral valvular disease III Effect of valvulotomy *Circulation, 13* 187, 1956

Werko, L , Biorck, G , Crafoord, C , Wulff, A , Krook, H , and Eliasch, H Pulmonary circulatory dynamics in mitral stenosis before and after commissurotomy *Am Heart J , 45* 477, 1953

West, J R , Bliss, H A , Wood, J A , and Richards, D W , Jr Pulmonary function in rheumatic heart disease and its relation to exertional dyspnea in ambulatory patients *Circulation, 8* 178, 1953

Wierum, C and Glenn, F Electrocardiographic indications of significant mitral insufficiency in patients with mitral valve disease *Am Heart J , 53* 359, 1957

Williams, M H , Jr Pulmonary function studies in mitral stenosis before and after commissurotomy *J Clin Invest , 32* 1094, 1953

Wilson J K and Greenwood W F The natural history of mitral stenosis. *Canad M A J* *71* 323 1954

Wood J A. Alexander J K. Frank C. W West J R and Richards, D W Some clinical and physiologic effects of mitral commissurotomy *Circulation* *13* 178 1956

Wood, P An appreciation of mitral stenosis. *Brit Med J* *1* 1051 and 1113 1954

Yu P N Beatty D C. Lovejoy F W Jr Nye, R. E. Jr and Joos, H A Studies of pulmonary hypertension VII Hemodynamic effects of acute hypoxia in patients with mitral stenosis *Am Heart J.*, *52* 683 1956

Yu P N., Harken D E Lovejoy F W Nye R E. and Mahoney E. B Clinical and hemodynamic studies of tricuspid stenosis. *Circulation* *13* 680 1956

Zinsser H F., Jr and Johnson J The use of angiocardiography in the selection of patients for mitral valvular surgery *Ann Int Med* *39* 1200 1953

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